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EDITORIAL NOTES

Compost Manure and Pests.

We publish in this number the first of a series of articles upon the preparation of compost manure from agricultural wastes. No apology is needed for stressing the agricultural importance of this subject. The basis of agriculture is a fertile soil; and in the maintenance of this fertility lies the chief concern of a stable agricultural industry. The essence of the problem is the restoration to the land of the materials that constitute its humus-content. Ideally—so far as our present knowledge allows us to say—this restoration may be made through the compost pit.

Since the process of compost-making, adapted from the traditional methods of the Chinese, was first worked out at the Indore Institute for Plant Research, it has been widely employed in many countries, including East Africa. Local experience has now been gained; and it is with the intention of making this local experience available to all farmers that we have invited contributions to the Journal. The actual preparation of compost appears to present little difficulty; but there are two main obstacles to its economic production on the farm : the cost of transport of the bulky vegetable materials to the site of composting, and the provision of water. How these obstacles have been overcome we hope that our contributors will show. The article in this number by Mr. Beckley, of the Kenya Department of Agriculture, explains how the Indore system of compost-making has been adapted to suit local conditions.

To Sir Albert Howard, and his co-workers at Indore, the agricultural world owes therefore a great debt. His work has brought home to the agriculturist, not only the need for continual restoration of humus to tropical soils, but the manner in which the restoration should be done. Rightly he has urged the paramount importance of the nutrition of the plant. But, in his recent writings,[1] he has advanced along this road to a point where few scientific workers will follow him. "Insects and fungi," he says, "are not the real cause of plant diseases, and only attack unsuitable varieties or crops improperly grown. Their true role in agriculture is that of censors for pointing out the crops which are imperfectly nourished." The words "unsuitable varieties" of course beg the question; one of the first objectives of the plant breeder is to obtain varieties that are "suitable" in that they resist disease. Sir Albert's main preoccupation is, however, with nutrition, and that there is much truth in his views none will deny. Without doubt, against *some* diseases and pests "resistance seems to be the natural reward of healthy and well-nourished protoplasm." But, against others, the very converse is true. In a careful study of the attacks of the stainer insect upon cotton in Northern Rhodesia, Bebbington and Allan[2] report that "it is the most vigorous, healthy and best fruiting plants that suffer most." Harland[3] again quotes several insects of cotton with which "the healthier the plant is, the more it is relished by the pest." Any plant pathologist could multiply instances where there is no evidence at all that the nutrition of the plant affects the onset or progress of a disease.

Let us maintain then a balanced outlook. Successful agriculture can never be a one-factor problem. If we place correct nutrition of the plant as its basic need, and urge the use of the compost pit as the best way of meeting that need, we also warn our readers against neglect of other precautions that experience has shown to be necessary for keeping the plant in health. The maintenance of soil fertility is perhaps the first task of agriculture; but it is no panacea for all ills.

[1] Howard: *Empire Cotton Growing Review*, 13, No. 3, p. 186.

[2] Bebbington and Allan: *Empire Cotton Growing Review*, 14, No. 1, p. 31.

[3] Harland: *Empire Cotton Growing Review*, 14, No. 1, p. 52.

The Tsetse Problem.

Over a large portion of Tropical Africa tsetse flies and men, except as an apathetic and poverty-stricken remnant, are mutually exclusive; and under present climatic conditions the tsetse tends perpetually to increase its territory, to the extinction of most forms of human endeavour. The reversal of this tendency is the most formidable task facing the European administrations of Tropical Africa. Mr. C. F. M. Swynnerton, the Director of the Tsetse Research Department of Tanganyika Territory, has written an account of the whole subject in a publication noticed elsewhere in this number.[1] His treatment is of the most comprehensive nature: he views the problem as a Pan-African one; he compares the methods employed and the progress achieved throughout the continent; he presents in summary form, but with a wealth of exact statement, what has been learned of the life history of the several species of tsetse that must be attacked; and he discusses the best means of utilizing the new land that is being won. Careful investigation and experiment over a number of years have led to the conclusion that direct methods of control, such as are generally employed to combat crop pests, or biological control,

which has many instances of spectacular success to its credit, have little chance of defeating the tsetse. The problem is, moreover, peculiar in that, unlike other pests, the tsetse cannot be controlled to a satisfactory degree by mere reduction of its numbers; nothing short of its complete local extinction secures its territory for permanent human settlement. For these reasons, the attack that is being developed by Mr. Swynnerton's department is concentrating more and more upon modification of the environment so that it becomes unacceptable to the fly. Methods with this object can only be elaborated with the aid of a most intimate knowledge of the life of each species of fly, of the plants, the animals, and the climate in the habitat it prefers. The necessity for this knowledge has led to the amassing of a volume of co-ordinated ecological information, or, in other words, scientific natural history, that, at least for a tropical area, is without its equal.

It is for this reason that Mr. Swynnerton's publication appeals to a much wider range of interests than the entomological title might indicate. It includes, for example, valuable experience with aerial surveys, and in the provision of a water supply by the simplest expedients. The appendices are an astonishing storehouse of information: they include a ten-page glossary of ecological, vegetational and other terms which might well become the standard definitions for African workers; and lists of plants and mammals, with their habitats, native names in several languages, and scientific names. This information is nowhere readily available; any non-specialist who has ever tried to penetrate the jungle of botanical and zoological literature and nomenclature will be grateful for these summaries.

It is no secret that for some years the maintenance of Mr. Swynnerton's organization was precarious. It is difficult to believe that a cessation of its effort can ever seriously have been contemplated. With this exposition before us, the survival of the Research Department must be a matter for satisfaction to everyone interested in scientific natural history and to everyone who feels any concern for the future of Africa.

1 "The Tsetse Flies of East Africa," *Transactions of the Royal Entomological Society of London*, Vol. 84, 1936, xxxvi + 579 pp.; price, £5 10s. 0d.

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An International Grassland Congress.

The Fourth International Grassland Congress is to be held in Great Britain in July, 1937, under the presidency of Professor R. G. Stapledon, C.B.E., M.A., Director of the Welsh Plant Breeding Station and the Imperial Bureau for Herbage Plants, Aberystwyth, Wales. The previous congresses in this series have been held in Europe and membership was more or less confined to European members, but delegates will come to this fourth congress from Great Britain, the British Dominions and Colonies, U.S.A., and numerous other countries, members of the International Grassland Congress Association (Central Office in Leipzig, Germany).

The paper-reading sessions will be held in Aberyswyth from July 12th to 19th, but intending participants will be able to join in a tour of centres of grassland interest and selected farms both before and after these sessions. The tours have been so arranged that participants will have an opportunity to see something of British grassland farming, including live stock management, over as wide a range as possible. Special addresses will be given on certain evenings during the course of

the tours, when matters of general interest emanating from the tours will be dealt with.

The paper-reading sessions to be held in Aberystwyth will be divided into three plenary and two sectionalized sessions. The sectionalized sessions will deal with the following aspects of the grassland problem: —

(1) Ecology (including surveys), pasture and range management (including erosion control).

(2) Seeds mixtures (including lucerne for grazing); legumes for use in poor pastures.

(3) Plant breeding, genetics, and seed production.

(4) Manures and fertilizers.

(5) Nutritive value of pastures; fodder conservation.

(6) Grassland economics.

All particulars regarding the acceptance of papers and dates for receipt of abstracts and paper manuscripts may be had from the Joint Secretaries, Agricultural Buildings, Aberystwyth, Great Britain, to whom requests for the preliminary programme and application form for membership and all other correspondence regarding the Congress should be addressed.

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The Testing of Soils in the Field.

The need for a quick method for determining certain chemical properties of soils, applicable in the field without recourse to soil sampling and laboratory tests, is often felt, not only by the agricultural chemist, but often also by the general agricultural officer. The methods of colorimetric "spot" tests for metals and metallic radicles has been fully described by C. A. Spurway.[1] We have received from Dr. G. ap Griffith, Assistant Soil Chemist in the Department of Agriculture, Uganda, an account of a convenient testing outfit, readily transported on *safari*, but completely equipped with the necessary reagents and glassware. This account is of insufficient general interest for publication in this Journal; but readers who may desire details of the outfit are advised to communicate directly with Dr. Griffith.

[1] C. A. Spurway: Technical Bull. No. 132, Michigan State College Agricultural Experiment Station.

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Sir Frank Stockdale.

The congratulations of all concerned with the welfare of agriculture in East Africa will go to Sir Frank Stockdale, on the conferment of a K.C.M.G. Sir Frank is the Adviser in Agriculture to the Secretary of State for the Colonies, and since 1929 the guidance of agricultural policy in the Colonies has been in his hands. His recent tour of the East African territories will be in the minds of many readers.

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A Director for Amani.

The Secretary of State for the Colonies has appointed Mr. A. G. G. Hill, B.A., Agr.B., A.R.C.Sc.I., to be Director of the East African Agricultural Research Station, in succession to Mr. Wm. Nowell, C.M.G., C.B.E. Mr. Hill comes to East Africa from Mauritius, where for the past eight years he has served as Senior Geneticist in charge of the Sugar Cane Breeding Station. He is expected to take up his duties in August, 1937.

The Improvement of Native Agriculture
A Review

By E. HARRISON, *C.M.G., B.Sc., Director of Agriculture, Tanganyika Territory.*

It is a pleasure to read the five lectures* on native agriculture which have been delivered in England by the doyen of British agricultural science. Naturally, in doing so, one must have regard to the limitations placed on a lecturer who has to expound and analyse problems in connexion with a population and its activities in another continent and before an audience a proportion only of which possibly has had experience in Africa. It is noteworthy that Sir Daniel Hall, after his first essay, draws many of his illustrations from Africa, and within limits they are typical.

The lecturer proceeds from the fundamental to the specific, and finally discusses possible action. He rightly bases the whole problem on the maintenance of soil fertility, without which there can be no permanent advance in the condition of the population nor yet real improvement in their agriculture. He goes further, and indicates that there must be an improvement in the fertility of the soil, and discusses the agencies which operate in this direction. The fact that the Chinese in several parts of their country have made the land serve their purpose for centuries, and have been able to demonstrate an economy in its use, unsurpassed anywhere, through the application of principles of soil management which for long have been traditional, is an indication to those interested in Africa that the perils of over-population are remote. But the lecturer demonstrates that they are remote only if an advancing local agricultural practice is followed, and perhaps he might have added if individual migration is not especially checked.

To me, the lecture on the maintenance of soil fertility simply brings out the indisputable fact that native agriculture must become more diversified, and that crop residues should be incorporated in the soil, either through direct composting or preferably, as I think will be deduced from the lectures which follow, through live stock kept on the holding for milk, power, food, and manure. In his second lecture he descants on the evils of and recommends reform of shifting cultivation, which is merely the native method of a long fallow. Now it is a practice, and where shifting cultivation does not entail the destruction of forest the evils are not quite so great. But where the population is increasing and there is no thought given to, nor practice inculcated leading to, the maintenance and improvement of soil fertility, ultimately there is bound to be a crisis of some sort.

It is important to recognize that nuclei of people, some of them very large, keep cattle and practise shifting cultivation in occupied areas surrounded by "fly" bush. People are dense enough on the ground and cultivation is so extensive that "fly" does not hinder. A redistribution of fragmented holdings, and an organized attack on the surrounding bush country by people who are gradually displaced by increasing population, are indicated as an activity concurrent with cattle stalling, compost-making and land manuring. This is just beginning to shape itself, and requires direction. With the cattle we can

* *The Improvement of Native Agriculture in Relation to Population and Public Health*, by Sir A. Daniel Hall, K.C.B., F.R.S.: Oxford University Press, 1936.

begin the conservation of fertility and the reform of shifting cultivation at the centre, where the population tends to increase most relative to the land.

The author rightly dismisses the deliberate practice of green manuring as a major method of maintaining soil fertility in native areas; the system is used, but is incidental to the general farming operations of the native. No, he believes that the more intensive method of composting is the better practice, if we can get it adopted. The reason is not far to seek: many of our soils are "dead", they need inoculation with the organisms found in fermented material to make them "live", and they have to be kept alive by the frequent application of this material and also to be kept fortified by the small quantities of manurial constituents conveyed by composted material. Besides, it is the more economical and desirable method, especially where the population is dense.

In his third lecture he deals with overstocking and soil erosion and perhaps too extensive cultivation. He rightly points out that a change to "fixed" from "shifting" agriculture may involve a change in land tenure involving tribal discipline. We have to face this problem, which, in my view, it is better to do than to face a crisis which might ultimately follow if the need for change is disregarded. But as the change-over from shifting cultivation to fixed cultivation will be a gradual process, it is not too much to hope that the wit of man will contrive quietly to accommodate this change.

As regards overstocking, and by that he chiefly means an excess of cattle plus other live stock per square mile, however caused, by accumulation or by the advance of fly, he rightly points out that, in our present circumstances, the preservation of live stock by veterinary action tends to intensify overstocking and therefore damage to natural pastures. Surely, before one deliberately goes the length of preserving an excess of live stock on the land, some use must be found for the article preserved; in other words, it at least should pay for the cost of its preservation and, further, justify the action economically. It is a fact that yearly increase in the present cattle population, in East Africa at any rate, is insufficient to supply a reasonable meat diet for the population of these territories. This subject and the dolorous spectre of future erosion, added to the pictures to be seen to-day, is an appalling one and it will never be solved by being fearful of the result or of events which may be incidental to the process of reasonable solution. Obviously, the way to break down the cattle complex is to give the cattle a just economic value and an economic use, and then proceed from that. As regards substitute tokens, it seems a pity we have a lion on our coinage instead of a bull. I also wonder how much of the overstocking and soil erosion seen to-day in the Ukamba Reserve would have been avoided if the people had been permitted to buy all the sugar they wanted.

Soil erosion, however it may be caused —the destruction of forest by the axe and the hoe, extensive agriculture without safeguards, over-grazing and trampling by stock—is continuing and will continue; and it will cease in the effluxion of time when, by education and if necessary coercion, the people are taught to regard their land as sacred, themselves as its guardians, and their live stock as instruments for its use and preservation. The author indicates that the crux lies in the paucity of service and the lack of resources to provide outlets for stock, and, at the same time, the failure to multiply water supplies and effect reconditioning. Reconditioning would appal an individual

farmer; he would not farm an eroded property unless he had to, and, if he did, after putting it right, he would not destroy it again. The inference is obvious.

In his fourth lecture he turns to the native dietary, exposing the fact that, in common with many peoples of the world, the African's diet is not at all satisfactory. He reveals the plight of tribes left to subsist in a natural way on what they can grow and may glean as permitted by the varying seasons. The habit of taking thought for the morrow, i.e. providence, is sadly lacking; and because the fear of the tribesman that he may be ejected from his land by incursions and pressure from outside has waned, we should be proceeding to teach him not only how to make a living but how to live. He also attributes the lack of resistance to disease as in part due to dietetic deficiency, not alone as regards composition, but in quantity and in steady supply.

He then proceeds to consider native agriculture, or rather farming, in order to see how it may be shaped and rectified to provide a better balanced dietary, free from some of the deficiencies. Here again he comes up against custom, and the fact that the arduousness of preparation and the general availability of different kinds of food are determining factors. Furthermore, he recognizes that a cereal or a cereal substitute, like banana, *muhogo* or sweet potato, must generally be the basis of the ration, and that the rest of the diet should make up deficiencies in these. Undoubtedly there is much to be made up. The fats, the proteins and the ash are all deficient in the foods mentioned, and furthermore none of them contain chlorophyll. We therefore see that natives use the green leaves of cassava, sweet potatoes, grasses, tender tree shoots, herbs, native spinach, and in some places lettuce, cabbage, kale, cauliflower, etc., but in the main natives are restricted to a few simple moderately bulky foods.

It was hoped—and it is happening—that increasing prosperity, increased exertion, and the glimmerings of reason would induce natives to sell or consume cattle rather than conserve their stock until it dies of old age, etc.

He then goes on to discuss the production of more oil and leguminous foods, with their greater value in lime and other mineral constituents. Chief among them are the groundnut (*Arachis hypogea*) and sesame, both export crops, both of high nutritive value. There are also the many varieties of beans, peas and cowpeas; and he pleads for not only plant breeding in connexion with millets, and more nutritive if less abundant maize, but also with soya and other beans, principally for the production of types suited to the various areas, if not for export also.

Furthermore, he indicates that the coco-nut has a dietetic value, and he might have included in his survey the widely distributed pawpaw, the mango, rice, *mkweme* nuts, tomatoes, pumpkins, and the numerous natural berry plants, both permanent and annual, which are used by natives.

He refers to the value of milk from cattle and goats, to the meat from cattle, sheep and goats, and to the utility of poultry and eggs. A system for the improvement of live stock (i.e. such live stock as we have in Africa) is not difficult technically, but it is somewhat slow and costly. A successful large-scale effort has been made with poultry. He pleads for more effective and hand labour-saving implements and the utilization of oxen to lighten the labour and improve the output of the cultivator, and incidentally to maintain fertility.

Having surveyed the problem from fertility to dietary, his final lecture is de-

voted to administration. Almost all his proposals hinge on this, as it is the duty of the Administration of African countries, advised by technical workers, to find the means and to guide the native people at least into an advancing native civilization. He examines the various ways in which African communities are regarded, and he dismisses as unworthy both those who would preserve them as specimens and those who would merely exploit them. It is indicated that as the European has laid his hand on the country and will not tolerate internal war, even if he acts not directly but through native councils or through chiefs and elders, he must take heed of the consequences of his action in pacifying the country, and proceed in such a way as to assist in the organization of a new form of native society, based on monetary taxation, and not on personal service and tribute.

The new system he advocates requires,

(i) replacement of shifting by fixed agriculture, which will maintain a continuous production from a smaller area, and lead to a more balanced dietary;

(ii) the elimination of excessive live stock and the utilization of the annual increase of the remainder as food;

(iii) the continued prevention of erosion and the reconditioning of devastated areas.

He rightly states that education and demonstration must precede general action. He raises the question of the ability of the African to comprehend; but the native is a visual learner. "Learning the business of a material basis of living," i.e. training, he places first in our present circumstances.

Whilst he states that "the machinery for the improvement of native agriculture consists in the main of the agricultural staff and the administrative officer residing in the reserve," he notes the value of native trainees in agriculture from Jeanes and mission schools as a link between the officers he mentions and the vast bulk of the population. To us, this link is all essential.

He deprecates the failure to reinforce trained agricultural staff in the colonies since 1931, and also the fact that the efforts of the agricultural staff have been largely concentrated on plantation industries and the growing of export crops for sale. He recognizes this as inevitable, as he must, because we cannot progress unless we have a "material basis of living". But I do not think that the author comprehends—at least, he does not indicate—the various kinds of work that have been done in the direction of the avoidance of famine. It is a fact that, until risk of famine and famine conditions have been overcome, it is idle to expect people to attend to export crops. After that one has but to guard against famine. Furthermore the growing of food is the chief business of the African. In Tanganyika, we estimate that the indigenous population must produce, acquire and consume about one million tons of food a year, whilst the surplus production for export from native areas hardly reaches 100,000 tons in the same period. Whilst the author states that, in 1929, of 42 technical agricultural officers in Kenya only 12 were employed in the native reserves, the fact is that, in East Africa as a whole, by far the vast majority of technical agricultural officers are concerned with native agriculture directly. In Tanganyika at least 90 per cent of the European staff are associated with native agriculture.

He states that scientific laboratory workers may not have had native agricultural problems brought to their notice, and rather indicates that native agricul-

ture for subsistence has been only incidentally regarded by agricultural and administrative officers.

He is rather impatient of the type of scientific work hitherto done, and states that but little has been undertaken on the basic questions of the restoration of humus and the maintenance of soil fertility, but gracefully recognizes the work of scientific officers, "struggling with an excess of questions to which there is no ready-made answer." He appeals for the reinforcement of scientific research by the provision of more workers in that sphere.

He recommends the establishment in each village of a *shamba,* or native farm, operated on proper lines by the cultivator, and also at native village schools; that is, an amplification of the present arrangements. Native instructors should be employed to guide these demonstrators, and he says instructors should get their initial training from the agricultural officers who also will supervise them. He properly remarks that, for the improvement in the dietary and the extended use of milk, female instructors would be most effective. But the main propaganda must rest with the administrative staff, as they are the prime source of authority and deal with the chiefs. He considers the example and teaching of the chiefs to be of great importance.

He advocates a policy of general betterment, for which a general plan should be prepared on which may be based the special plans for each district. Then he discusses, or rather states, what it means: improvement of the native farm, composting, disposal of human excreta, better crops, amelioration of the dietary, consumption of milk, culling of live stock, the use of cattle as draught animals, the selection and management of stock and possibly fencing. The prevention of erosion and the regeneration of the wasted areas are in the programme; the rotation of grazing, the sinking of wells, and construction of dams. He recognizes that the process is costly and slow, as do those of us who have in hand parts of a programme leading to what I would term a planned countryside. To-day we can only gradually carry out the programme piecemeal here and there, but it is being done.

He opines that the Home Government has never contemplated such a programme, but that on it lies the main burden of making Africa fit for the African. He says that it need not be pure philanthropy, because there is trade to follow, and Africa is part of the great British estate with many potential economic citizens of the Empire. The people of Great Britain, too, are suffering from ill-conceived dietaries, and a national campaign is needed there; and for a time the lecturer departs from the consideration of native agriculture to the subject of nutrition in England with equally arresting data.

Finally, he closes with a résumé of his findings and his opinions, and points out that what he proposes is but a palliative to save the existing population and that of the near future, not as a means of increasing population, but as a method of "conserving the very soil itself". From these palliative measures he anticipates that the amount of food available will be increased and "the standard of living of the native will be raised and that, as experience seems to show, will be accompanied by an automatic reduction in the rate of increase of the population." If the population increases out of proportion to the carrying capacity of the land, the measures taken will ultimately fail, but we need have no present fear; Africa is pretty empty. I am afraid that a system of agriculture which aims at the permanent maintenance of a high native population

must also admit of the production of a surplus, otherwise I see little in the proposal but philanthropy.

I think that, on the author's survey, it will be realized that the problem here requires a mass education and development project, possibly somewhat on the lines of the "Sing Hsien" project commenced in 1926 by Dr. Y. C. James Yen and a group of workers in China. This project is a colossal one, and is being prosecuted there in the hope that it will eliminate four fundamental weaknesses which make China a problem, namely, ignorance, poverty, disease, and civil disintegration. Our problem is quite comparable and I am sure not insuperable.

These lectures are a timely reminder by a greater leader of agricultural thought that agricultural services are in the main educational and ameliorative, and that with the Administration lies the responsibility, not merely for law and order and finance, but also for the planning and direction of development and the leading of the native into a comprehension of what is required and what it all means. None of it is new to workers in these fields, but he has rendered a service in bringing prominently into focus that a course of interlocked action, based on agriculture, is needed for the advance of indigenous peoples in Africa.

These lectures do not need a review; they require a reply.

The Unsuitability of Certain Virgin Soils to the Growth of Grain Crops—III

Dr. W. Small, Director of Agriculture, Nyasaland, supplies the following information concerning native practice in Nyasaland. The procedure described will be of interest to others concerned with the problem of the failure of grain crops on newly opened lands. This subject has been discussed in the *East African Agricultural Journal*, Vol. II, No. 2, p. 145, and No. 4, p. 313:—

" In the opening up of land which has lain fallow for a few years, the natives always do a 'burn' in mounds for the first year's maize crop. They assert that without the burn the crop would fail. The burn is slow and mild, dry grass or the turned sod being fired within the mound. The intensity of heat is very much less than that generated in the burning of the soil for finger millet cultivation which is done in parts of the country."

Notes on the Storage of Foodstuffs

Maize and other Cereals

Compiled by the Imperial Institute, London.

For the safe storage of maize in bulk it is essential that the grain be thoroughly dried in order to prevent heating and mould, and that the moisture content be less than 14 per cent. In addition, precautionary measures must be taken to discourage insect pests, of which the most destructive is the rice weevil (*Calandra oryzae*). Grain containing more than 20 per cent of moisture will not only begin to heat but is particularly favourable for the development of weevils, the optimum moisture point for which is between 17 and 20 per cent. Weevils are unable to live in dry grain containing less than 8 per cent of moisture, and are unable to carry on active life in the absence of air. These conditions must be aimed at as far as possible in storing the grain.

Various methods of storing maize are used in tropical, sub-tropical, and other countries. The method adopted by the natives in various parts of Africa of storing corn on the cob and in the unhusked condition, either in small, specially erected buildings on their farms, or on shelves or racks in their houses, or hung up in various ways, may be satisfactory for small quantities of maize to be kept for short periods, more especially in the case of the hard and flinty varieties, but such methods are not suitable for storing grain in bulk for any length of time.

On the Gold Coast maize has been successfully stored in airtight petrol or kerosene tins. Corn so stored showed no appreciable loss of weight, and proved to be free from weevil attack after a period of eight months, whereas well sheathed corn stored in a native barn showed a decrease of 25 per cent in weight and was of less attractive appearance.

Grain in bulk is generally stored in tanks, or buildings specially constructed for the purpose, such as silos, galvanized iron sheds, or elevators.

Three efficient methods of storing maize in sealed airtight tanks may be briefly described as follows:—

(*a*) The tank is rammed completely full of maize before sealing, the metabolic process going on in the grain being apparently sufficient to exhaust the remaining oxygen and to fill the tank with carbon dioxide.

(*b*) Lighting a candle in a nearly filled tank before sealing, which exhausts the oxygen and fills the tank mainly with carbon dioxide.

(*c*) Fumigation of the maize in the tank with carbon bisulphide or carbon dioxide gas and sealing down quickly.

It is stated that maize can be successfully stored by these methods without danger of heating. It is important, of course, that the corn be thoroughly air-dry before being put in the tank and also that the tank itself be dry; this can be achieved by lowering a can containing hot coals into it before putting in the maize.

Corrugated galvanized iron containers are the most efficient and economical type of tank for the storage of maize. Such tanks can be constructed in sections, the sides being riveted and soldered at the joints, and the lower end of each section of the tank should overlap the section below in order to keep out moisture. The lower sections should also be of a stronger gauge than the upper, in order to withstand the greater pressure. The tank itself should rest on a concrete or wooden

platform, and supports should be placed round it to hold it against the wind when empty. For filling the tank a scaffolding and small platform are necessary; the opening at the top of the tank can be sealed by means of a flanged lid, the flange of which fits between two circular collars, the inner one of which is higher than the outer, in which space oil is filled, thus making the tank airtight. A lower opening is also desirable for fumigating purposes. If it is found necessary to fumigate maize for the prevention of weevil, 1½ to 3 lb. of carbon bisulphide for every 100 bushels of grain, according to tightness of packing of the grain, may be used. This can be poured into saucers or on to cotton waste placed in dishes put on top of the grain to be treated. The tank should remain airtight for a period of twenty-four hours, after which the fumes must be allowed to escape by openings at the top and bottom, care being observed not to smoke or place a light near the fumes. Fumigation with carbon bisulphide does not injure the grain for food, and the disagreeable odour passes off on exposure to the air.

In South Africa, grain is usually stored in bulk or in sacks, either in tanks, rooms, lofts, or elevators, while for co-operative purposes, large sheds made of galvanized iron are used in the corn-growing areas. In Rhodesia a simple and effective way of storing mealies is stated to be in a square brick building with a granite floor. They are poured in through a trap door at the top of one wall, and removed by a hole two feet long by one foot high at the bottom. This leads into a trough, with a hinged door on top of it, which can be locked.

When sheds are used for the storage of maize in sacks they should be so constructed as to admit the maximum amount of air and light. This is particularly necessary in humid climates. If weather conditions permit, the sides may be constructed of heavy gauge wire-netting, while the roof should project sufficiently to prevent beating by the rain. Should weather conditions make wire-netting sides impracticable, walls having large doors and ample window space fitted with movable wire-netting frames should be provided. Cement, concrete, or tight wooden floors are desirable, as they can be cleaned easily. When storing grain in sacks it is important to prevent them from coming into contact with the floor. This can be achieved by stacking in rows, on poles, rafters or beams, running parallel with the shed, in such a way as to allow space for inspection and circulation of air to ensure dry grain and preven overheating.

Fumigation may be carried out in the shed by placing each sack on a tarpaulin and treating with 2 oz. of carbon bisulphide, the liquid being thrown on to each sack in order that it runs through on to the grain. The bags are then covered by folding over the tarpaulin and left for 72 hours.

Grain stored in bulk may be fumigated with carbon bisulphide at a dosage of 5 pints per 1,000 feet of space, including that occupied by the grain. If the grain is of considerable depth the carbon bisulphide must be distributed partly on the surface and partly at a depth of 5 feet. The latter is effected with the aid of a thin metal tube inserted into the grain at intervals of 5 feet. Fumigation should not be carried out when the temperature is below 70° F.

In the United States of America seed-corn curing and storing houses are used for maize storing; these are so constructed as to provide free ventilation and artificial heat when necessary, also protection from insects, rodents, and weather damage.

Such houses are built on high and narrow lines, having two or three stories, as the warm air rises more effectively in such buildings. The air may be heated to a temperature of 109° F., though temperatures ranging from 80° to 100° are generally effective, and the heat should be maintained to keep the corn to a moisture content of 14 per cent or less.

Rice and wheat require similar precautions as regards moisture and protection from weevil as maize, but the moisture content of the rice before storage should be lower, viz. 12 per cent or less.

In India, wheat has been successfully stored by putting it into open-mouthed receptacles and covering the grain with a layer of sand. A sheet of cloth, wood or iron may be placed in between to prevent the grain becoming mixed with the sand.

Beans.

In storing beans for food, artificial heat may be used for drying; as in the case of maize, the seeds should be thoroughly cured to reduce moisture content, as undue moisture leads to moulds, and heating may result. Good ventilation in the store is essential, and providing the moisture is kept at a minimum the temperature factor is not so important. The bean weevil, which is the chief pest of stored beans, begins life in the field and breeds in dry seeds; consequently treatment should be resorted to as soon as the seeds are ready for storage. Heat and fumigation are the best remedies. Weevil-infested seeds may be poured into boiling water, which is drained off at once, followed by a thorough drying before storing. An alternative method is to heat the seeds to a temperature of 145° F. or higher. Fumigating with carbon bisulphide is one of the best methods of treating infested seeds. The seeds should be placed in an airtight room or tank and treated with 1 oz. of carbon bisulphide for every 100 lb. seed for 48 hours. When applied at a temperature of below 60° F. the amount of carbon bisulphide used should be increased. The liquid may be sprinkled over the surface of the pile without injury to the seeds. After treatment, the seeds should be exposed so that the fumes will be liberated.

Groundnuts.

These can be stored for long periods if kept in the undecorticated condition, but they soon deteriorate after shelling. When storing groundnuts, precautions should be taken against rats and mice, and the store should be well ventilated and dry. Groundnuts are usually stored in sacks or cribs, similar to those employed for the storage of corn.

Yams.

The most satisfactory manner of storing yams is by arranging them in layers, three or four feet deep, on shelves in well ventilated rooms. The tubers should be mature before harvesting, and care should be observed during lifting operations and storage to avoid damage by bruising. Bruised tubers are liable to fungoid attack, and should be treated with Bordeaux mixture or slaked lime to prevent spread of infection. In the West Indies the yam scale is sometimes a serious pest, as it continues breeding on stored roots and causes them to shrivel. In various parts of Africa the Dynastid beetle (*Heteroligus claudius*) is one of the troublesome pests of the yam crop. Yams may also be stored in small heaps in well ventilated rooms, protected from rats and mice, or in pits, though this method cannot be recommended unless the soil is thoroughly dry and likely to remain so. In West Africa the natives in certain areas store their yams in a specially constructed "yam house". These "buildings", which are of

a temporary nature, are made from materials obtained in the locality, and consist of a number of posts arranged a small distance apart in the form of a square or oblong on which the yams are tied; sometimes the "buildings" have a roof of light thatch or palm leaves to protect the yams from the sun, and, if on a large scale, additional racks running down the centre.

Under all conditions of storage, yams require regular inspection to remove diseased tubers, otherwise infection will spread rapidly, resulting in considerable loss.

Cassava.

Cassava tubers do not store well for any length of time after removal from the ground and exposure to the air. Cassava "chips", however, can be kept for a long period. The preparation of cassava chips consists of peeling and slicing the roots (or splitting and cutting into pieces a few inches long and an inch or less thick), followed by drying in the sun until very crisp. When the chips are required for use they may be pounded and sieved, in order to separate the fibre from the flour.

Sweet Potato.

In storing the sweet potato, similar precautions to those required for the storage of yams should be observed. The sweet potato has a thin delicate skin, and is therefore particularly liable to injury; consequently, when lifting, great care should be taken to avoid cutting or bruising, which lead to decay. The loss from carefully handled sweet potatoes may amount to as much as one-sixth less than that from others less carefully handled. Though sweet potatoes may be left in the ground for varying periods after maturity such practice is undesirable, as sprouting and decay tend to take place. In Trinidad various methods of storage have been attempted experimentally. These consisted of storing in clamps or pits (with or without ventilation) and in layers of sand, in bags, and in a well ventilated store, in heaps, piled on sacking, and on shelves in layers three or four inches deep. Of these methods the most satisfactory appears to be storage in pits (either ventilated or unventilated), decay being almost negligible and loss due to shrinkage low. The tubers stored in bags showed less decay but considerable shrinkage. Decay was not marked in the case of the tubers stored in the heap, but the loss through shrinkage was high.

In the United States of America considerable attention has been given to the question of storage of the sweet potato on account of the great losses occasioned by market gluts shortly after harvesting the crop. Special sweet-potato storage houses, built of wood, brick, hollow tile, cement or stone, are used for the purpose. After harvesting, the crop is conveyed to the store, where it undergoes a curing process in order to heal wounds sustained during lifting. This consists of maintaining a temperature in the store of 80° F. to 85° F., with a relative humidity of 90 per cent and sufficient ventilation to prevent condensation of moisture for a period of ten days to two weeks. When the curing period is over, the temperature of the storage house is reduced to as near 55° F. as possible, and maintained as nearly as possible at this figure, and at a relative humidity of 85 to 90 per cent, throughout the storage period. Such high humidities tend to check shrivelling and internal breakdown, and to protect roots against infection.

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Goats and Soil Erosion

The class of animal farmed also has its bearing on the damage inflicted on the vegetal cover, and so on the soil, because some animals maltreat certain types of sward more than do others. In this respect the goat is one of the chief offenders. The goat feeds on a wide range of plants and will utilize the pasturage on rugged land inaccessible to other classes of farm animals. In certain areas the popularity of the goat has been largely due to the fact that it can survive drought—which it accomplishes by feeding on tall shrubs and young trees—better than do cattle or sheep. In denuding the slopes of shrubs and young trees it contributes to erosion in no mean measure. It is relevant here to point out that the actively growing part in grass is found at the base of the leaf, and, in consequence, the removal of the upper part of the blade by grazing does not injure the growing point. It is for this reason that grass lends itself so well to pasturing. In the case of shrubs and trees the growing point is terminal, which when eaten off causes greater setback than in the instance of grass. Shrubs and trees, after the grass has been destroyed by excessive grazing, must be looked upon as the last stronghold of the soil. If these are destroyed, and here the goat in some districts is the chief agent, nothing remains to hold the soil, even mechanically. The goat then would do least damage when farmed on grasslands. In many districts where it is to-day popular the goat in fact does most damage.

The various classes of animals show a different predilection to edible plants; in consequence Nature's interplant relationships are best maintained where farmers employ more than one class of animal in their farming. In general, cattle do less damage to vegetation than sheep, and sheep less than goats. Among the contributory agents fostering the excessive erosion which has taken place on land farmed by natives is the native's partiality to the goat.

(Extracted from: Publications of the University of Pretoria, Series No. 1, Agriculture No. 37, "The Interdependence of Animals, Crops and Pasture." by H. D. Leppan, B.Sc., Agric. (Toronto), M.Sc. (Cantab.), Professor of Agricultural Economics.)

Some Aspects of the Poultry Industry in Kenya*

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The low prices for grain crops that have prevailed during the past few years have emphasized the desirability of converting them in part into other products before they leave the farm. For this reason, a large number of farmers turned to poultry as a side-line to their other activities. Although prices of produce have now risen appreciably, yet the industry has become soundly established; and, in spite of higher food costs, is likely to remain profitable, but only as a side-line, when the fullest utilization of surplus produce can be made. As a proposition by itself, where all foods would have to be purchased and transported, there is probably not very much scope in Kenya, for, apart from the difficulties that arise where large numbers are handled, the outlet for poultry products is not at the present time sufficiently great to justify a large expansion. The possibilities of export of eggs have, however, been explored, and results to date are encouraging, particularly in the South African market at certain seasons of the year.

While there is a fairly steady demand for eggs, the marketing of surplus cockerels and old hens, particularly the latter, is a very difficult problem in up-country districts, although in the vicinity of towns there may be a small demand. Therefore the policy should be, as far as possible, one of egg production and the elimination of surplus cockerels at the earliest possible stage. For this reason, the desirability of sexing day-old birds, a practice now adopted on a very large scale in Europe, would be extremely useful in this country. It should be pointed out, however, that the determination of sex by the available method is by no means easy, and it requires a great deal of practice before accurate results can be obtained. The alternatives to the above method are the use of sex-linked crosses, or of light breeds in which the cockerels can be distinguished at about three weeks of age. Although this last method entails the expense of rearing a large number of redundant males to the age of three weeks, yet it is probably the most practicable method at the present stage; the use of sex-linked crosses involves the maintenance of two separate flocks of pure-bred birds and the rearing of a fair number of pure-bred stock to provide material for the selection of breeding birds.

The choice of breeds, as outlined above, is largely influenced by the presence or absence of a market for the meat, and will lie therefore in most cases with the light breeds. Apart from these considerations, it is important to remember that it is desirable to choose a breed already well represented in the country, so that there will be a sufficient number of strains to prevent inbreeding, a danger in a country where it is of the most vital importance to maintain the constitution of the stock. There is always a tendency to degeneration of progeny of imported stock, this being noticed particularly in size and weight and composition of the bone. In the opinion of the writer, however, these difficulties can, in large measure, be overcome by rigorous selection of breeding stock and careful feeding of suitable rations and mixtures containing the necessary mineral ingredients.

* Reprinted from *East African Agricultural Journal*, Vol. I, No. 4, January, 1936, with additions.

There is little doubt that in some breeds, in particular the White Leghorn, the policy of breeding largely for high egg production has to a certain extent been overdone, with the result that constitution and stamina have tended to be lost. In England at the present time there is a distinct change in favour of the less high producing breeds and strains. In the opinion of the writer, however, in a country such as Kenya, where an egg-machine is very desirable, the White Leghorn is likely to be predominant. If mortality amongst young and adult stock is becoming high, then there is a strong argument for using a first cross with a heavier breed with more stamina, such as the Rhode Island Red. It is most essential to realize that, if this practice is adopted, the first cross birds should not be used for breeding, but a sufficient number of pure-bred birds of each breed kept to provide the necessary stock for the breeding pens.

It is of great importance to adopt a definite policy and to continue with it. The introduction of a large number of breeds and indiscriminate mixing lead eventually to the segregation of many bad types, and do not, as is sometimes supposed, improve the constitution of the stock.

Problems of Housing.

As a rule, housing is not a difficult problem in this country, except in so far as it entails strict attention to cleanliness and protection from vermin of all sorts. A very important fact to bear in mind is that poultry always thrive best in small units, an economic unit being about 30 birds.

For this reason the Hosier system of portable housing units, each unit comprising about 20 to 30 birds, has much to recommend it, but it has also three grave disadvantages: —

(1) It is not suited for heavy breeds, as they do not get enough exercise and tend to get too fat.

(2) Adequate provision for shading the units is essential, as the birds will never thrive if exposed all day to the sun in one of these units without protection.

(3) The grass on which the birds are folded should be short. Folding on tall herbage of the red oat grass type leads to chills and scouring through the birds running about in the long grass when it is wet with dew or rain. Further, they are liable to suffer from impaction of the crop through eating coarse and fibrous material.

Apart from these two latter pitfalls, and the fact that in East Africa it is probably suited only to light breeds, it combines the advantages of keeping birds in small numbers; protection from vermin (since the unit is completely enclosed; house and run being made as one); and the provision of fresh unstained land for the flock.

A considerable amount of experience has now been gained of this system in Kenya, and the author is much indebted to Mr. G. R. Morrison, who has allowed him to make observations on his flock, which is housed by this method.

Its success for the production of eggs has now been definitely established in the case of the light breeds; and, further, it has been shown that feeding costs can be considerably lowered under this system, for the provision of abundant young grass enables the amount of protein fed to the birds to be reduced very appreciably. Moreover, a progressive increase in the quality of herbage takes place in many areas as a result of this intensive folding and the cultivation which the birds do to the grassland.

There is no doubt that the system is forcing for the birds, particularly when the grazing on which they are being kept

has been folded several times over, and cases are known where there has been a considerable mortality of laying hens due to ruptures, broken eggs, etc. For this reason, it is probably inadvisable to fold the birds frequently over the same area of land. Use should be made of fresh areas, and the older areas rested under a different system of grazing, being ideally suited to calves and rearing stock. After they have been thoroughly rested, the units can be folded over them again.

The importance of providing shade in the form of maize trash or straw laid over half of the roof area of the run should be emphasized, particularly in the hotter areas.

If, however, the difficulties enumerated above cannot be overcome, or heavy breeds are kept, some form of permanent house and run must be used. It is then most important to ensure that adequate provision is made for resting the runs, so that a grass cover can be maintained. The most obvious method is to divide the run into two in such a way that it can be served by the one house. The house itself can be of very varied design, and many excellent types are to be seen in the country. A wire-netting floor (of small mesh—about 1 in.) is highly desirable, so that the droppings may fall through, either into a platform underneath which can be moved and cleaned or, if the house itself is movable, to the ground. The whole house can be put on a fresh site when the ground has become stained. Obviously, houses of this type must be raised off the ground; and it is in fact always desirable that this should be done so as to provide a free circulation of air underneath. Birds should not be allowed to roost on the wire netting, but should always have perches provided. For these it is better to use properly cut and planed timber than rough branches which are not so comfortable to the birds' feet. To lessen the risk of birds eating the eggs, nest-boxes should always be as dark as possible. They should have a front which can be shut down at night to prevent birds roosting in them. There is no need to divide nest boxes into partitions, one large box being easier to disinfect and keep clean.

Obviously, the type of house mentioned above is most suited for small units, but where units of 100 birds or so have to be housed a more permanent type of building with a wooden floor is required. For the roofing of poultry houses opinions differ whether corrugated iron or grass should be used. While grass undoubtedly keeps the house cooler, it is essential that it should periodically be completely removed and burnt, and the roof re-thatched, so as to prevent vermin from being harboured in it. The same remark applies to the use of scratching sheds where the birds are provided with straw in which their corn is scattered. Unless these are thoroughly cleaned out and the straw burnt at frequent intervals, it is probably better to dispense with them altogether.

There is one fault closely connected with housing that is liable to occur, and that is the indiscriminate mixing of birds of different ages. This is in some cases due to the collapse of partitions between runs, etc., but is due also to the fact that the harm done by such a practice is not always realized. Apart from the fact that the distribution of food is likely to be uneven, there is always a tendency, when the older birds cease to lay and start to moult, for younger stock to go into a neck-moult which will either delay them from coming into lay or will put them off if they have already commenced. For this reason flocks should always be segregated as far as possible into pullets not yet laying, pullets six months to one year, birds over one

year, birds over one-and-a-half to under two years, and birds of two years and over. This will not usually involve any additional housing, but will yield much more satisfactory results. The fact that there is no definite hatching season in this country has probably been one of the chief factors contributing to this mixing of ages, for it entails a continuous supply of birds of all ages, and thus segregation becomes difficult; but provided the birds are divided into the categories described above results should be quite satisfactory.

Feeding.

The feeding of the birds will, to a large extent, depend on the foods that can be grown on the farm. In most districts these provide a fairly extensive variety, but at all times it is necessary to supplement with certain purchased foods, such as wheat offals, etc. As a general rule, maize bulks large in the ration fed to the birds, its chief recommendation being its cheapness. It is important to realize that many of the digestive disorders that occur (excessive scouring, liver troubles, etc.) are probably due in large measure to the use of maize in excessive quantities either in the mash or corn mixtures. The relatively high price of chick wheat in relation to maize has deterred farmers from using it in sufficient quantities, with often very unsatisfactory results. It should be remembered that there are other foods in addition to maize and wheat, such as buckwheat, barley and sunflower, all of which can be grown cheaply on the farm and used in a certain proportion to the corn ration. It is unwise, however, to make any of these the basis of one's corn ration, which should always, so far as possible, be wheat, with these other grains in smaller quantities.

Finally, it is important to note that it is always preferable to feed good wheat in preference to droughted or pinched grain.

Examples of rations are:—

2 parts wheat,
1 part crushed maize,
1 part sunflower.

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3 parts wheat,
2 parts crushed maize,
1 part buckwheat.

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3 parts wheat,
1 part barley,
2 parts crushed maize,
1 part sunflower,
1 part buckwheat.

Maize should be fed kibbled, and sunflower slightly bruised so as to break the outer husk. If one kind of grain is fed by itself, then wheat is preferable, the remainder being more suited to mixtures. A bird in full lay should receive 1½ oz. of grain per day, preferably in two feeds, in the early morning and evening.

There is a considerable divergence of opinion as to the desirability of feeding dry mash or wet mash. One of the chief advantages of dry mash feeding is economy of labour, an important consideration in Europe, but less so in this country. Unless carefully controlled, there is always the danger with the dry mash system that the birds will be eating an unbalanced ration; since they are able to pick the food over at will, its composition tends to alter, and this may cause digestive disturbances. Further, since skim milk, which may be utilized for mixing with the mash, is frequently available in this country, the case for wet mash feeding is strengthened.

While the majority of the corn rations can usually be produced on the farm, it is essential to purchase certain feeding-stuffs for the mash portion. These are chiefly pollards, bran, and meat meal. The latter can probably be replaced, at least in part, by the use of vegetable protein, e.g. soya beans, together with a mineral supple-

ment. In this latter connexion, it must be remembered that nearly all the foods are themselves deficient in minerals, and it is therefore of great importance to add a complete mineral supplement to the rations. In this way growing birds will be enabled to form hard bone; the not uncommon crooked breast-bones, probably due to soft bone which has easily become bent, will be eliminated, and the minimum number of soft-shelled eggs will be laid. It is worth stating, however, that in the flock there are always a few birds that will lay soft-shelled eggs, however adequate the mineral supplement in their ration may be. This is due either to hereditary taint or some constitutional defect. Such birds should not, of course, be selected for breeding.

The chief minerals of importance, and those most likely to be deficient, are lime, phosphate, salt, and iron (sometimes). These are most readily added to the ration in the form of ground limestone, steamed bone flour or meat and bone meal, salt finely ground, and iron oxide if necessary. The last is usually only required for young brooder and rearing chicks where there is a lack of iron in the soil. Salt should always be finely ground, as it is toxic in large quantities, and should for this reason not be in a lumpy state when fed. The total mineral constituents should constitute about two per cent of the ration. If meat and bone meal is being fed, no steamed bone flour is necessary. The proportions of the minerals should be roughly as follows:—

Salt	... ...	½ per cent.
Ground limestone	...	1 per cent.
Steamed bone flour	...	½ per cent.

When iron oxide is being fed to young stock, only about ¼ per cent need be included.

A suitable laying mash would be as follows:—

With Skim Milk.

45 parts pollards,
15 parts bran,
30 parts maize meal,
8 parts lucerne meal,
2 parts minerals.

100

Or

45 parts pollards,
15 parts bran,
30 parts maize meal,
5 parts soya bean meal (or other vegetable protein),
3 parts meat and bone meal,
2 parts minerals.

100

Without Skim Milk.

45 parts pollards,
13 parts bran,
25 parts maize meal,
10 parts soya bean meal,
5 parts meat and bone meal,
2 parts minerals.

100

Or

45 parts pollards,
15 parts bran,
25 parts maize meal,
5 parts meat and bone meal,
8 parts lucerne meal,
2 parts minerals.

100

The feeding of greenstuff is, of course, always highly desirable, and this should consist largely of kale, cabbages, etc. Poultry, as a rule, are not very fond of lucerne when fed long, owing to the large amount of stem present in relation to leaf. For this reason, if it is desired to feed lucerne, it is best to grind it up finely and incorporate it in the mash. The stemmy material is all reduced by the grinding and rendered more palatable to the birds. So treated it has a high feeding value, for it is rich in protein, and is, of course, largely used in Europe and America in the dried powder form as alfalfa meal to replace some of the protein in the mash.

The introduction of hammer mills into the country increases the possibilities of the use of lucerne meal, and, in view of the fact that suitable purchased animal proteins are difficult to obtain, more extended use should be made of it. It is most essential, however, to grist lucerne which has been made into hay under shade and on which all the leaf is present. Ideally, of course, a meal composed entirely of the leaf would be the most valuable, since the stem has a fairly high fibre content. Suitable rations for laying birds, making use of alfalfa meal, have been listed above.

Mention has already been made of the fact that under the Hosier portable system the amount of protein fed, when the grazing has been improved, can be reduced appreciably. Suitable rations are appended below, based on experience accumulated under conditions in this country. These conditions do not obtain for birds under free range, which should be fed rations as outlined previously.

Hosier System.

A.—With Skim Milk.

50 parts pollards,
20 parts bran,
28 parts maize meal,
2 parts minerals.

100

B.—Without Skim Milk.

50 parts pollards,
15 parts bran,
25 parts maize meal,
5 parts lucerne meal,
3 parts meat and bone meal,
2 parts minerals.

100

In addition to oyster-shell for the birds, it is essential to provide some sharp grit in the mixture, if the soil does not already contain a sufficient quantity. The grit must be sharp, as it is required to perform in the gizzard the grinding action necessary for efficient digestion. Often it is possible to find some rock or stone locally which, when broken up with a hammer, will serve the purpose.

The system of feeding outlined above is somewhat expensive, but it is amply justified for pullets and second-year birds in full lay. In actual fact, on to-day's prices for maize and wheat offals and supposing that no skim milk is available, a suitable mash ration would cost Sh. 4/50 per 100 lb. and a suitable corn ration Sh. 4 per 100 lb. On these figures, and allowing for the fact that a bird will eat about 50 lb. of mash and 31 lb. of grain yearly, the total cost of feeding a bird will be in the neighbourhood of Sh. 3/50 per annum. On an egg yield of 150 eggs per annum, feeding costs will be in the neighbourhood of 28 cents per dozen eggs. Where skim milk is available and the Hosier system practised, this figure should be reduced by at least 5 cents per dozen.

Frequently, owing to lack of a market, it is impossible to dispose of old birds when their period of maximum usefulness has passed; they probably continue to lay a few eggs, but not in sufficient quantity to justify elaborate or expensive feeding. Such birds are probably best ranched out in portable houses, risking vermin damage and allowing them free range. In this manner, with a cheap corn ration consisting largely of maize, and possibly a little mash if the birds are in poor condition, although even this may be unnecessary, eggs will be obtained with the minimum expenditure, until such time as the birds cease to yield a return or preferably until a market can be found for them. It is extremely important to cut expenditure to the minimum on such stock. The return will not be high and output is not likely to be affected appreciably by very cheap feeding, since quality of food has ceased to be the limiting factor in the bird's capacity to produce

eggs. This again emphasizes the great importance of segregating birds into egg groups.

The use of sprouted grain for poultry food, in particular for breeding stock and laying hens, offers distinct possibilities in this country. It is a useful food of high nutritive value. It is very digestible, and provides green food for the birds during the dry season. It can be used partly to replace the grain and partly to replace the mash rations. Any of the cereals can be used for the purpose—oats, barley and maize being the most readily available in this country. They should be steeped in water for two days before being germinated, and should then be spread out on trays in a store from which light is partially excluded, and allowed to germinate until the shoot is approximately 3 inches long. The whole plant—shoot, remains of the grain, and root—is fed to the birds, preferably in a trough. Trials are being conducted at Njoro to test the best means of germinating the grains and securing the best results.

Culling.

In every flock there is certain to be a percentage of birds which do not yield a sufficient return to justify the feeding. Some of them might be treated in the manner suggested for old hens if they cannot be disposed of in any other way. These birds are of two types, and are best discussed separately:—

(1) *Wasters.*—These are birds which never put on flesh, but are always in a thin and unhealthy condition. They are chiefly found amongst the light breeds where there has been a tendency to breed for egg production, sometimes at the expense of constitution. These birds are never likely to be of any use, even to run with a "cull" flock, and should be destroyed. They are always easy to detect by their poor condition and lack of comb and wattle development, or bad coloration of these organs.

(2) The other class consists of birds which are healthy in appearance, but, either genetically or constitutionally, incapable of high egg production. These can only be culled by frequent and careful handling of the flock. They usually tend to be loose-feathered birds, with a marked tendency in the heavy breeds to lay on large quantities of yellow fat internally. The head and comb are usually coarse and thick, and frequently the feathering in the heavy breeds is carried right forward over the head, the feather being of a coarse and bristle-like nature. The distance between the pelvic bones is narrow; their points are large, and feel definitely knobby as opposed to the finer points in a good layer. The region below the pelvic bones is usually lacking in capacity, with a tendency to a rather tight and hard skin. The scales on the legs, instead of being set on tightly, are frequently loose and of rather an open nature. A common feature of an unsatisfactory bird is the length of claw; but this criterion should not be applied in this country, where many of the soils are deficient in gritty material, with the result that the amount of wear and tear on the claws is very small.

Great attention must be paid to the proper handling and culling of all laying stock, and, unless the birds are trap-nested, selection of breeding stock will depend on this handling also.

Selection and Handling of Breeding Stock.

If trap-nesting has been practised, the selection of breeding stock is rendered relatively simple, for the records of a large number of birds are then obtainable, and selection among the best of these is made on characters such as size, constitution, thriftiness, character of bone, and breed

points. As it is often difficult to trap-nest, owing to lack of suitable labour and facilities, in the majority of cases breeding stock must be selected by careful handling on the lines previously indicated. Where a flock has been culled regularly, this should prove a relatively simple matter, as the farmer will by then have acquired a sound knowledge of the technique of the handling of birds. If possible, no female stock should be used for breeding until the birds have reach the age of at least twelve months. By attention to this feature, the minimum number of weakly chicks will be obtained. In the heavy breeds, fifteen months is an ideal age for the selection of breeding stock. The male bird of a light breed can be used at an age of about eight months, and of a heavy breed at ten months, by which time he will have grown well. The use of birds at earlier ages than this definitely retards growth, and, as has been suggested, may affect the constitution of the offspring. At the other end of the scale, it is very common to observe a decrease in the fertility of the eggs after the breeding stock have reached an age of about 2¼ years, depending on the breed. In most cases this is due to the male bird, and the number of females should then be reduced. Initially, in a light breed, about 12 females should be allowed to one male bird, although 15 can be used, provided he is well grown and at an optimum age of about 1½ years. In the heavy breeds, the number of 10 females should not be exceeded.

It is frequently advisable also to select a small pen of six to eight really first-class birds for purposes of cockerel breeding, and these are mated with an unrelated purchased male. In this manner a sufficient number of male birds are obtained for mating with the rest of the breeding stock, without incurring the expense of the purchase of a large number of unrelated males. It is of great advantage to trap-nest such a pen, as any surplus cockerels can then be sold with a definite record behind them, which will naturally enable a higher price to be obtained. Such individually bred birds can be hatched in the incubator in the normal way, by placing all the eggs from one of these six birds together in a small cage after about the eighteenth day. All the chicks from one hen can then be toe-punched at birth or marked with a numbered ring affixed to the wing or leg before they have had the opportunity to get mixed with the rest of the hatch, with which they may be reared in the normal way.

In the ordinary breeding flock it is often desirable to run two male birds together with rather over double the number of females that would normally be allowed to a single male, as this usually leads to a higher fertility in the eggs. The chief objection to this system is that two male birds are often liable to fight; but the risk of this is usually much lessened when the birds have been reared together and when the breeding stock is allowed a fairly free range.

The feeding and management of breeding stock is substantially the same as that of the laying flock. A higher percentage (about 2 per cent more) protein should be included in the mash, and the birds should be allowed as much exercise as possible, not being confined in small runs or kept under the Hosier system. That this system is definitely not suited for breeding stock of any breed has been proved. The male becomes sluggish and the fertility of the eggs low. Absolutely free range, which is the ideal for breeding stock, is often difficult in this country on account of vermin. Confinement, even in fairly large runs, appears to affect fertility appreciably, and those farmers who have been able to allow their breeding stock

free range have had successful results reflected in the fertility of the eggs. Where trap-nesting is practised, the eggs should, if possible, be graded, for it is frequently found that certain birds lay consistently small or misshapen eggs, unsuited for hatching purposes, and such stock should be discarded.

In the selection of the eggs themselves for hatching, a good deal of care must be exercised. An egg weighing between 1¾ and 2 oz. is about the ideal size. An egg over 2 oz. is not desirable for hatching. In addition, care should be paid to such characters as shape, uniformity of shell, and cleanliness. The presence of an appreciable amount of dirt closes the breathing pores. A slightly stained egg can, however, be cleaned with a dry or very slightly damp cloth.

All eggs to be used for hatching should be kept in a cool store, with as uniform a temperature as possible, until it is desired to use them. They should be turned daily if possible during this storage period and no eggs more than ten days old should be used for hatching. The practice of storing these eggs in bran or sawdust until required is not a very good one, and it is preferable to stand them on racks or other suitable containers, so that air may circulate all round them.

Methods of Hatching.

The majority of farmers in this country prefer to use incubators, but the broody hen has much to recommend it. Some of the larger poultry farmers in England are now returning to the use of these natural methods, in the belief that by so doing they retain the vigour and stamina of their stock. The great drawback in this country to the use of the hen is the problem of vermin, and unless the birds are clean this method should not be used. The author is indebted to Mr. T. Y. Watson for a method of keeping the broody hen free from vermin, by the use of a couple of green tobacco leaves, which are placed under the nesting material. The idea is that, while the hen is sitting, the heat given out is sufficient to give off nicotine vapour. The leaves should be changed every two days. At least one farmer in this country has adopted the excellent practice of having the coops for sitting hens made out of sheet iron, so that they can be readily cleaned and freed from vermin. A series of these can be placed under a grass roof to prevent them from getting too hot during the heat of the day. Where a large number of chicks are being hatched by this method, it is desirable to tether each broody hen by one leg to its nest; in this manner no confusion can arise when they are removed for feeding. All sitting hens should be removed daily and allowed access to corn and water; but laxative foods should not be given, as they lead to fouling of the nest and eggs.

Towards the end of the incubating period it is desirable to damp the nest, for there is always a tendency for the eggs to become dry, and a certain loss through "dead in shell" will result. The advantages of the use of sitting hens may be summed up in a few words by saying that hatching by this method is simple when one is dependent on unskilled native labour, that the percentage hatch is usually greater than from an incubator, and that it is cheaper in first costs. The disadvantages are that many breeders who have only light breeds will have no sitting hens for the purpose. In that case it may mean keeping a certain number of birds of a breed such as the Light Sussex, which has hitherto proved to be unsatisfactory from the utility point of view in this country on account of the relatively small number and size of the eggs it lays. Alternatively, it may be possible to obtain

a certain number of native hens; but these are often covered with vermin and, being small, will not usually cover the full number of eggs. Moreover, it is difficult to obtain the required number of such broody hens at any given moment.

The majority of breeders will therefore use the incubator, but in this case frequent and strict European supervision is necessary, without which it will be almost impossible to obtain good hatches. In this country it would appear that the hot-water incubators are definitely preferable to the hot-air types, chiefly on account of the smaller temperature variations in the former. The author has traced several cases of poor results from incubators in this country to failure to test the capsule before every hatch. This can always be done by immersion in hot water, making sure that it expands fully. The thermometer should also be tested in hot water against a clinical thermometer. Frequently also the buildings in which the incubators are housed are at fault. Ideally, an incubator should be housed in a cellar with a through draught created by windows placed high up on either side of the room. In this manner a fairly uniform temperature is maintained and good aeration is secured. The floor of the room should be firm and level, so that the incubator does not rock about and subject the eggs to vibration. While the practical difficulties usually preclude the construction of a cellar in this country, the principles embodied can be preserved by constructing a thick-walled mud and wattle hut, roofed with corrugated iron, the whole roof being then covered thickly with a layer of grass, maize trash, etc., to ensure a uniform temperature. Ventilation should be provided in the manner described above. Preferably the hut should be situated where there is shade overhead. The incubator itself should be run empty for several days before it is used, to ensure uniformity of temperature before the eggs are introduced. The practice of marking each egg with a nought (o) on one side and a cross (×) on the other is always advisable, in spite of some opinion that this is not necessary for only in this manner can complete turning be ensured, which is essential for successful results. The shallow troughs provided for water in the incubators should be kept filled, always filling with warm water, which will give off vapour immediately and maintain the necessary humidity in the atmosphere. The floor of the incubator house should be covered with sand, which can also be kept damp. The most successful results seem to have been obtained by running at a temperature of slightly over the accepted figure of 103° F. Very good results have been obtained up to 104° F. Great attention should be paid to the turning of the eggs, and they should be turned completely twice daily. Great care must also be exercised in the handling of the eggs, as one defective egg in the incubator can liberate gases that will prove toxic to the developing embryos.

The incubator should not be opened again after the 18th or 19th day, depending on the temperature at which it has been running; but the thermometer must be examined very frequently after this, because heat develops rapidly as the young chicks respire actively in their shells. After hatching, no chicks should be removed from the brooder till thoroughly dry, but they should be allowed to stay in the special compartment for this purpose. The latest hatched chickens may be left in the incubator after the others have been removed and introduced into the brooder at night. For the first day the chicks require no food, but water and fine grit should be provided. The practice of feeding hard-boiled egg is unnecessary as the chick has considerable reserves of food in its body, which it requires to

digest before it is induced to eat other foods. On the second day after removal from the brooder, a mash can be commenced. A specimen is appended below. Skim milk should be fed separately to very young chickens, although if desired a very small quantity can be used to make the mash into a very stiff paste, which should be crumbly in texture. Where skim milk is not available, a proportionately higher amount of protein will be required, and the inclusion of 1 per cent of cattle cod liver oil is extremely desirable. Great care must be taken, however, in mixing this with a mash, since it is important to incorporate it uniformly so that no excess will be present.

Mashes.
Percentage Figures.

With Skim Milk.

	Brooder.	*Grower.*	*Fattening.*
Pollards ...	50	45	30
Bran ...	20	28	14
Maize meal ...	23	20	50
Meat and bone meal ...	5	5	4
Minerals ...	2	2	2
	100	100	100

Skim milk *ad lib.* to breeders and fattening birds; to others more limited quantities.

Without Skim Milk.

	Brooder.	*Grower.*	*Fattening.*
Pollards ...	45	40	30
Bran ...	18	21	13
Maize meal ...	18	18	50
Meat and bone meal ...	9	9	—
Lucerne leaf meal ...	8	10	5
Minerals ...	2	2	2
	100	100	100

(*Note.*—A brooder is a bird up to 8 weeks, and a grower any bird over this age up to time of laying.)

The ration inserted for fattening birds is suitable for surplus cockerels which it may be desired to rear for the table. Chopped greenstuff in the form of cabbage or kale leaves, or very finely chopped lucerne, can be usefully incorporated in the mash, but on account of its rather fibrous nature, it is best not to use lucerne until the birds are eight weeks old, unless the leaf meal is obtainable. The small runs provided for the brooder chicks should be moved constantly, and should always be kept on short grass. Any long grass will inevitably lead to chills and other troubles. Again one must emphasize the importance of segregation of age classes in rearing as well as in adult stock. The rather common practice of mixing rearing chickens of all ages is quite a possible cause for the appearance of a high percentage of "runts". All unwanted male birds should be selected as soon as possible, and fed on the cheaper ration for fattening birds. Where prices are low, or demand for such birds poor, this ration can safely be commenced at a relatively early age, and if necessary a portion of the mineral ration can be omitted. For young chickens the iron oxide is a most essential constituent of this ration, and should not be omitted. It is important to remember that iron is an essential constituent of the blood, and that lack of it may produce a fair proportion of wasters in the young stock.

A corn ration should be given to the rearing stock at the age of about 3½ to 4 months, depending on the breed. If maize is used as one of the ingredients it should be kibbled small. Owing to the rapid rate at which stock grow and mature in this country, many farmers wish to retard their birds from coming into lay in order that they may be given a good chance to grow out. The only way in which this can safely be done is to move them to fresh sites constantly; any system such as reducing protein in the ration is to be deprecated in the case of a growing bird.

Provided that the birds have been well fed, there should be little danger in too early laying, and drastic methods to delay this should not be adopted.

It is important to remember that the profitable laying life of a light breed does not exceed (particularly in the case of White Leghorns) two years, and the heavy breeds after this age usually tend to put on a large amount of surplus fat. If it is not possible to dispose of stock when this time has been reached, costs of production should be lowered by feeding them as cheaply as possible since the return from them will no longer justify expensive feeding.

Conclusion.

In this article an attempt has been made to show that, provided management is conducted on sound lines, there is a considerable future for poultry as a sideline to mixed farming in Kenya. It would appear likely that with increasing production the possibilities of increased export will come to front, and prices may fall. Profits will then only be possible if continued progress is made in good management.

AGRICULTURAL RESEARCH IN THE SUDAN.

Important changes in the organization of agricultural research in the Sudan are recorded in the latest annual report.* By the amalgamation of the Gezira Research Service and part of the late Wellcome Tropical Research Laboratories, a consolidated Agricultural Research Service has been constituted under the direction of Mr. M. A. Bailey. A staff of 27 European officers devoting its whole time to research has thus been largely concentrated within a single institution, pivoted on an efficient scientific library. The annual budget amounts to about £59,000.

* Annual Report, Agricultural Research Service for 1935 (Part II of the Annual Report of the Department of Agriculture and Forests), Khartoum, xi + 183 pp.

Bearing of Recent Physiological Research on the Shade Problem in Arabica Coffee Cultivation

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The chapter on "Shade" in all books on coffee-growing with which I am acquainted may roughly be transliterated thus: —

"Lots of people think that shade is quite a good thing, so perhaps the planter ought to put some in. Mind, the amount of shade must be just right; not too heavy, and yet not too light. No, I can't give you the slightest idea what is right. You will have to find that out for yourself.

"Of course, all this must not be taken to mean that shade is *necessary* or even that it is *desirable*. Lots of the best people don't believe in it at all, and say that the coffee bush needs all the sunshine that it can get. And, of course, they *may* be right. Who knows?

"Perhaps the best thing for you to do is to make up your mind on the subject. After all, whatever you do decide to believe in, you will find heaps of people who will agree with you."

That this is not entirely exaggerated can be seen by reference to two fairly recent books, McDonald's *Coffee Growing with Special Reference to East Africa*[1] and Zimmerman's *Kaffie*.[6] The former devotes some three thousand words to a discussion of the advantages and disadvantages of shade, wherein the arguments for and against are balanced so thoroughly that they cancel themselves out, while Zimmerman, as an advocate of shade, platitudinously discusses the subject at similar length. Rarely is any definite guidance to the planter evident, and rarely indeed are data given on which he can base his own judgment.

In this article I do not pretend to offer a complete solution to the shade problem. But I do present definite evidence bearing on it. The information obtained is general, that is to say, it is applicable to all districts; moreover, it is definite, in that it rests on experimentally ascertained facts, and not on empirically acquired opinions.

The coffee plant is a great consumer of carbohydrate. Large quantities are required for growth purposes, and carbohydrate forms nearly the whole of the crop. So much indeed is used that a heavy crop sometimes exhausts the supply kept in reserve by the tree, giving rise to one form of yellowing and dieback.[2] Since the consumption is so great, and since a shortage produces such evil effects, it is imperative to ensure adequate amounts for growth and for cherry formation. We cannot supply carbohydrates to the tree as we can manurial constituents. The tree manufactures them for itself by photosynthesis from water and the carbon dioxide of the air. The energy necessary for this process is derived from sunlight by means of chlorophyll.

The most obvious difference between shade and the open is that there is less light under shade; and we know that light forms the source of energy for photosynthesis. Here we have a connexion between our shade and our coffee tree; a connexion, moreover, that we can measure and investigate.

Any planter, persevering enough to have read so far, will at once put the following questions: —

"What, then, is the rate of manufacture of carbohydrate by coffee leaves in

different light intensities? And what is the effect of shade, natural shade, as it occurs on our own *shambas*? And, in particular, what is the effect of shade on my own *shamba*? "

These questions have been answered. In order to do so it has been necessary to work out a method whereby, over so short a time as a few minutes, the amount of work done by the leaves can be measured, that is to say, their photosynthetic rate determined. As the apparatus is complicated, only the principle will be described here. A current of ordinary atmospheric air, of known velocity, is drawn through a small cup glued to the underside of a coffee leaf. This air contains a measured amount of carbon dioxide, but some of this is absorbed during its passage over the leaf and thus the amount present in the outgoing air is reduced. If we know the time taken, the volume of air passed, the carbon dioxide content of the air before and after its passage through the cup, and the area of leaf surface exposed to the air stream, we can readily calculate the rate of photosynthesis. The measuring apparatus has to be so sensitive that it can measure less than one five-millionth of an ounce of carbon dioxide (6×10^{-6} gm.). All results are expressed as the amount of carbon dioxide absorbed by unit leaf surface in unit time. The figures quoted here, as is conventional, are expressed as so many thousandths of a gram of carbon dioxide absorbed by 100 square centimetres of leaf per hour. (Roughly, in ounces of carbon dioxide absorbed by 280 square yards of leaf surface per hour.) We need not bother with the absolute value of these figures, however. If we think of them as units of work, or units of photosynthesis, we shall not be far wrong. They actually represent the rate at which the leaf factory is banking its profits, some to be used for extensions to the factory premises, some as running expenses, while some is eventually to be paid out in the form of crop, this capital levy representing a dead loss to the plant.

The first result, an unexpected one, is that the amount of work done by a coffee leaf is small, even under the most favourable conditions. The average value is about 2.5 units, and the maximum recorded is only 4.5. When these figures are compared with those from temperate plants, where values of up to 25 units have been recorded for apple leaves, we see that the old idea of a universal high photosynthetic rate prevailing in the tropics is erroneous.

Most of my early work was done on potted plants, placed outside the laboratory, and quite unshaded. I soon noticed that photosynthesis dropped almost to zero whenever the sun shone. This was very surprising, since we know that light is necessary for photosynthesis, and it seemed absurd that an increase in the supply of power to the factory should slow down production. However, it soon became apparent that this stoppage of photosynthesis by sunshine during the hours from 9 a.m. to 4 p.m. always took place. Under artificial shade, or during cloudy weather, photosynthesis went on unchecked all day long.

At this stage in the work I was able to borrow a travelling laboratory from the Department of Agriculture of Tanganyika Territory. This meant that I could take my apparatus on estates, and so measure the amount of work done by leaves growing in the plantation under natural conditions. The main outlines of the results obtained could have been predicted from laboratory data, but it is much more satisfactory to know exactly what happens under natural conditions. It is always desirable for the worker to carry his work to the field, and the planter is more likely to accept his con-

clusions if they are based on results obtained on a plantation.

Work was done, therefore, on two estates, so chosen that different degrees of shade, from very dense to no shade at all, were obtainable. In addition, the soils were very dissimilar, one estate being on a Kilimanjaro red soil, while the other was on a typical Meru volcanic ash soil.

Each record obtained in the field shows the rates of photosynthesis for every half-hour between the hours of 3 a.m. and 10 p.m. A selection of these is published elsewhere.[3] Each time a measurement of photosynthetic rate was made, notes were taken of the weather conditions, and also of the type of shade falling on the leaf. Unfortunately, I did not have sufficient time to measure the actual amount of light.

The results are clear-cut. During a cloudless day on an unshaded estate, the coffee leaf begins to manufacture carbohydrate soon after dawn. By 8 a.m. the rate rises to about 4 units, but drops to zero by 9 a.m. It does not rise again until about 4 p.m., when photosynthesis again starts, but falls again to zero just before dark. At any time of the day photosynthesis recommences if the tree, or even the single leaf, is shaded artificially, or if a passing cloud obscures the sun. Under shade, although the rates in the early morning are not quite so high as in the sun, they are fairly high throughout the day, and, moreover, they correspond with the amount of shade falling on the leaf. During the midday hours very light shade, such as is thrown by a high, feathery branch of *Grevillea*, permits of only slight manufacture. Moderate shade permits of normal rates. Very dense shade, such as found in the interior of a coffee bush, permits of low rates, but at least higher than rates in full sun.

The following table shows the approximate average rates, throughout the day, in the conditions stated:—

	Units.
During dull, cloudy weather ...	1.5
During a cloudless day (no shade) ...	0.7
During a normally bright day (heavy shade)	1.4
During a cloudless day (moderate shade)	2.1

Now the coffee leaf absorbs carbon dioxide during the day only. At night it gives off carbon dioxide, just as we do ourselves, and about 0.7 units per hour are lost to the plant in this manner. That is to say, about 8 units are lost during the night. Subtracting this from the figures for total income during the day, we have, roughly, a total daily profit to the leaf of—

	Units.
During dull, cloudy weather ...	12
During a cloudless day (no shade) ...	1
During a normally bright day (heavy shade)	11
During a cloudless day (moderate shade	19

The figures show that a leaf in full sun has only a small margin of profit at the end of a day's work, whereas under moderate shade a considerable amount of carbohydrate is available for storage as reserve. While this finding does not apply *in toto* to the whole bush (for reasons that will become evident later), yet to a certain extent it is true of that also, since the behaviour of the coffee bush is a partial reflection of that of the leaves.

The explanation of this state of affairs is as follows: Carbon dioxide enters the coffee leaf through the stomata. These pores can open and close, and it is obvious that, when they are closed completely, little of any carbon dioxide can enter the leaf. Thus photosynthesis will be reduced or stopped, although conditions may be otherwise favourable for it.

Now the stomata of coffee, probably because it is a plant adapted to shade, are

very sensitive to excess of light.[4] If of greater intensity than about one-third of full mid-day sunshine, it causes them to close completely. Up to that intensity it causes opening in rough proportionality to the amount of light. Thus we have a satisfactory explanation of the observed changes in the rates at which the leaf can do work. In dull light the stomata are moderately open, raw materials can enter the factory, and can there be manufactured into carbohydrates. An increase in light increases the rate of manufacture, since it provides more power, and also opens the doors wider to raw materials. But a further increase, although supplying still greater energy, results in the closing of the stomata, thus cutting off supplies until a reduction in light permits raw material to enter once more.

Summarizing the present state of our knowledge, we have now reached the following conclusions: —

(*a*) In certain districts, particularly those with much sun, the carbohydrate income of the coffee tree only just covers requirements. In fact, a heavier crop than normal often produces an overdraft on the carbohydrate account. This overdraft, unlike a financial one, generally results in the death of the possessor.

(*b*) An unshaded coffee leaf, if exposed to direct sunlight during the hours from about 9 a.m. till about 4 p.m., does not carry out any carbohydrate manufacture. A reduction in light intensity during these hours will increase the daily carbohydrate income considerably. The effect is the same whether the reduction is brought about by artificial or by natural shade, or by cloud.

It is thus seen that experimental study of this problem has led to conclusions directly contrary to certain ones arrived at some years ago by Sanders and Wakefield,[5] through lack of experimental data, on a theoretical argument. Experimentally ascertained facts are not to be gainsaid; a theoretical argument always has loopholes for error. I would therefore point out to the planters that the above conclusions are based on facts; but as to their interpretation into plantation practice I can only offer certain opinions. Unlike this article as a whole, the following paragraphs represent my present *opinion*. It is not necessarily correct.

I have seen no evidence in any coffee area in favour of any hypothesis attributing debility in the coffee tree to any excess of carbohydrates. On the contrary, vigorous and leafy trees, growing under such conditions that maximal manufacture of carbohydrates might legitimately be supposed to take place, normally remain thrifty, and produce adequate crops. I am therefore of the opinion that the planter will be wise to encourage maximum carbohydrate formation by all means within his power.

He can do this in several ways. In some districts shade will suffice. In others, if much cloud prevails, shade will be unnecessary, and might even be deleterious. Shade can be dispensed with, at least in some districts, by so growing the tree that it shades itself. A very leafy tree has the majority of its leaves in shade at any time. One such tree, on a completely cloudless day, had 45 per cent of its leaves shaded all the time, while 67 per cent were exposed to the sun for less than two hours. In districts where a growing shade is inadvisable, I would commend to the practical man the increase of leafage by appropriate pruning methods. Thus the rate of production of carbohydrates by the whole tree can be increased.

In conclusion, I wish to emphasize that this article deals with one aspect only of

the shade problem. It is quite possible that further researches will show that shade exercises a depressing effect on other plant functions. If this should prove to be true, then a balance will have to be held between the various effects of shade. At present, all that we *know* is that shade results in increased manufacture of carbohydrates by the coffee leaf during sunny days, and that for maximum photosynthesis the light falling on the leaf should be rather less than one-third of full midday sunshine (0.6 gm. cals./cm.^{2}/min.). It is also my *opinion* that this additional carbohydrate income will have a good effect on the plant and on the resulting crop.

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Experiments on the Maintenance of Soil Fertility in Uganda

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It has often been said that it is not the function of agricultural science to prove that rule of thumb practices are wrong, but rather to find out the reasons for such methods, and, having arrived at an understanding of the method, to try to improve it. This is never more true than in tropical agriculture. In most parts of the tropics prior to the impact of western civilization no attempt was made to produce crops for export, and the acreage of land under cultivation was therefore only what was necessary to supply internal needs.

In some parts of Uganda the agricultural system practised is what is known as "shifting cultivation". The native cultivates a plot of land until it no longer pays, then leaves it and opens up a new plot. In the course of time, he returns to the original plot, which has in the meantime achieved a cover of grasses, shrubs, and even young trees. This is nothing less than a rotation, the length of which depends only on the area of land available per cultivator in that district.

This system amply supplied the needs of the time when the populations of men and cattle were, for various reasons, stationary or even decreasing. The advent of the new civilization changed the whole agricultural outlook. Economic crops were introduced and the area under cultivation increased rapidly. At the same time, more settled conditions and the application of medical and veterinary science stopped the wastage of human and animal life by war and disease. This necessarily increased the pressure on the land, and reduced the length of resting period in the native rotation. The great increase in area of cultivation brought with it an increase in the size of individual plots. In many places the economic crops are in large communal holdings, and the loss of rich top-soil by erosion has become much more rapid than in the days of small plots scattered in the bush. On land which has suffered erosion, grasses, shrubs, and weeds take much longer to establish, and the process of regeneration is unavoidably slowed down. In the more thickly populated areas, then, the pressure of population calls for a shorter resting-period, and the losses by erosion, leaching and burning-out of organic matter make regeneration a slower process. The result is a gradual loss of fertility.

In Uganda, as elsewhere, all the earlier experimental work, aiming at a solution of this problem, dealt with rotations in which a green manure crop was expected to maintain fertility and soil structure. Detailed results of these experiments may be found in the Annual Reports of the Uganda Department of Agriculture; it is sufficient to say here that in one experiment, repeated for five successive years, a green manure crop, grown in the early rains, failed to improve the yield of cotton sown in the late rains. On the Serere farm, with a rotation including green manures, it was found that it was necessary to plant two green manure crops a year, since no cover planted in the spring rains could be maintained through the dry season. The land was therefore ploughed and harrowed twice

each year to obtain the tilth for sowing the leguminous crop. The purely mechanical effects of the implements in pulverizing the soil, coupled with the fact that the land was bare for some time after sowing the fresh crop, increased the loss by erosion to such an extent that it far outweighed any gain there might have been by the incorporation of the green crops. The loss of fertility was such that, after a few years, most of the old farm had to be abandoned. This leads to the thought that the use of implements, particularly the plough, may actually increase the rate of loss of fertility.

The net result of the rotation experiments and of the experience with the old farm at Serere was extremely valuable, in that it showed that the old line of approach to the problem of maintenance of fertility was never likely to lead to a solution. It then became necessary to start again and consider the reasons for the loss of fertility and how to combat the various factors concerned.

On flat or nearly flat land, nutrients are carried off in the crop and lost by leaching. The rate of loss of organic matter by oxidation is increased by cultivation operations, and eventually soil-structure is lost. Finally, the very heavy storm rainfall, normally experienced in Uganda, puddles the soil surface when it is left uncovered; and the finer soil fractions may be carried down into the soil, to a greater or less depth, to form an impacted layer, which in wet weather produces an artificially high water table and waterlogging, and in dry weather a hard layer which restricts root development. On sloping land, over and above all the above factors, there is the danger of erosion. This of course varies with the slope and type of soil, but is greatly enhanced by the impacted layer already discussed, which is the more to be feared when texture has been lost. In fact, the key to the problem is just as likely, if not more likely, to be physical as chemical.

Having considered the factors that make for loss of fertility and having given up the old line of attack as unlikely to succeed, we naturally return to native practice, find out its merits, and see how it can be improved. Observations have been made for some time by field officers on discarded native plots, in order to follow the normal ecological succession of grasses and shrubs in the various districts. It was found that it took a long time to establish a reasonably complete cover, and even then there was a lack of bottom grasses, so that erosion, though slowed down, was still a factor to be considered, especially where these old lands were grazed. These observations led to the first step in the improvement on the native rotation: to accelerate the process of regeneration by planting the cover on old land, instead of waiting for it to come naturally, thus saving two or three years. To obtain an idea of the best type of cover to plant in the various districts, experimental plots of grasses were laid down. In Elephant-grass country it was found in 1933 that a complete, almost impenetrable stand can be obtained within six months, on land that has been cropped continually for five years.

Another way in which the native practice in Uganda may be improved is by the use of manure. Even in the best cattle districts, no attempt has ever been made to keep cattle in covered kraals and to make and use the manure.

After reviewing the results of previous experiments in the short grass areas of the Eastern Province and taking into consideration the experience gained at

Serere, the writers drew up a comprehensive scheme of experiment to discover: —

1. The minimum period of rest necessary to maintain fertility.
2. The best type of cover during rest.
3. The effect of green manuring.
4. The dosage of animal manure necessary in conjunction with the above.
5. The relative effects of ploughing and hand-cultivation on soil erosion.
6. The best simple anti-erosion measure compatible with peasant farming.

It was later found to be impracticable to include all these inquiries in one experiment. Points 1 to 4 are now covered by what is to be known as the Fertility Experiment, and points 5 to 6 by an anti-erosion experiment. These proposals were forwarded to the Agricultural Adviser to the Colonial Office, and thence to the Statistical Department of the Rothamsted Experiment Station, for criticism of the objects and lay-out. The experiments are now being established in the form shown below.

The Fertility Experiment.

Four types of resting-period cover are to be used for comparison with natural weeds and grass. They comprise planted grass undisturbed, planted grass lopped to simulate grazing, green manure turned in, and green manure lopped to simulate grazing.* As each type of cover is to be tried for one-, two- and three-year periods, there must be fifteen rotations, and each treatment is to be grown with no manure, 2½ tons kraal manure, and 5 tons of kraal manure per acre, applied once in the rotation. The details of the rotations are shown in Table I.

* All loppings are left on the land, to compensate in part for animal droppings.

TABLE I—THE FERTILITY EXPERIMENT

Year	Rotation 1	Rotation 2	Rotation 3	Rotation 4	Rotation 5
1. Spring ..	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
2. Spring ..	Eleusine.	Eleusine.	Eleusine.	Eleusine.	Eleusine.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
3. Spring ..	Groundnuts.	Groundnuts.	Natural weeds and grass.	Groundnuts.	Groundnuts.
Autumn .	Sweet potatoes	Sweet potatoes	Ditto	Sweet potatoes	Sweet potatoes
4. Spring ..	Natural weeds and grass.	Sorghum.	Ditto	Planted grass.	Sorghum.
Autumn .	Ditto	Cotton.	Ditto	Ditto	Cotton.
5. Spring ..	Ditto	Natural weeds and grass.	Ditto	Ditto	Planted grass.
Autumn .	Ditto	Ditto	Ditto	Ditto	Ditto

TABLE I—THE FERTILITY EXPERIMENT—(*Contd.*)

Year	Rotation 6	Rotation 7	Rotation 8	Rotation 9	Rotation 10
1. Spring ..	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
2. Spring ..	Eleusine.	Eleusine.	Eleusine.	Eleusine.	Eleusine.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
3. Spring ..	Planted grass.	Groundnuts.	Groundnuts.	Green manure lopped.	Groundnuts.
Autumn .	Ditto	Sweet potatoes	Sweet potatoes	Ditto	Sweet potatoes
4. Spring ..	Ditto	Green manure lopped.	Sorghum.	Ditto	Planted grass. lopped.
Autumn .	Ditto	Ditto	Cotton.	Ditto	Ditto
5. Spring ..	Ditto	Ditto	Green manure lopped.	Ditto	Ditto
Autumn .	Ditto	Ditto	Ditto	Ditto	Ditto

TABLE I—THE FERTILITY EXPERIMENT—(*Contd.*)

Year	Rotation 11	Rotation 12	Rotation 13	Rotation 14	Rotation 15
1. Spring ..	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.	Preparation of Land.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
2. Spring ..	Eleusine.	Eleusine.	Eleusine.	Eleusine.	Eleusine.
Autumn .	Cotton.	Cotton.	Cotton.	Cotton.	Cotton.
3. Spring ..	Groundnuts.	Planted grass lopped.	Groundnuts.	Groundnuts.	Green manure dug in.
Autumn .	Sweet potatoes	Ditto	Sweet potatoes	Sweet potatoes	Ditto
4. Spring ..	Sorghum.	Ditto	Green manure dug in.	Sorghum.	Ditto
Autumn .	Cotton.	Ditto	Ditto	Cotton.	Ditto
5. Spring ..	Planted grass lopped.	Ditto	Ditto	Green manure dug in.	Ditto
Autumn .	Ditto	Ditto	Ditto	Ditto	Ditto

Rotation experiments are notoriously difficult to arrange in order to get the utmost statistical significance. In the present instance it might appear to be easy to start off with the whole experiment at once and assess the relative effects of the treatments by the yields of the cotton crop of the sixth year. From the statistical point of view, however, a much better sample of weather effects is obtained if every phase or stage of the rotations is represented in one year. As the rotations proposed cover a period of five years, we must have five divisions or cycles of the experiment, one of which is in its first year, one in its second year, and so on. This can be done either by starting Cycle 2 in its second stage (second year) and Cycle 3 in its third year, etc., or by opening only the area occupied by the first cycle in the first year, leaving the rest of the experimental area untouched until required.

The latter alternative has been adopted at Serere because it is easier to start off with 90 plots, increasing by 90 each year to the climax of 450, and also the final comparisons will be more valid. Thus, this year, the two blocks of Cycle 1 have been opened; next early rains these blocks will be in the first phase of their second year and two more blocks will be opened. In 1938 there will be two blocks in their third year, two blocks in their second year, and two just opened. In the fifth year the experimental area will be carrying representatives of each course or phase of each rotation.

Lay-out.

The rotations are to start in all phases with two replications of each rotation in each phase. (Land to be left virgin until required; for instance, this year only the two blocks of Cycle 1 have been opened up.) The complete experiment will consist of 150 large plots of one-tenth acre, each divided into three sections manured with kraal manure at rates of 0, 2½ and 5 tons per acre. The manurial treatments are randomized within plots.

PLAN

CYCLE I

Rotation

9	8	2	15	10	13	11	4	5	12	3	1	14	7	6
0	0	5	0	5	5	5	5	5	5	2½	0	5	2½	5
2½	5	0	2½	2½	0	2½	0	0	0	5	5	0	5	2½
5	2½	2½	5	0	2½	0	2½	2½	2½	0	2½	2½	0	0

Rotation

14	8	5	10	11	15	12	9	4	6	13	3	1	7	2
0	0	5	5	5	0	0	2½	2½	5	0	2½	2½	2½	5
5	5	0	2½	2½	2½	5	0	0	0	2½	0	5	5	2½
2½	2½	2½	0	0	5	2½	5	5	2½	5	5	0	0	0

CYCLE II

Rotation

2	11	14	13	9	5	6	10	15	12	3	1	4	7	8
2½	0	5	2½	2½	0	2½	2½	0	2½	2½	0	2½	0	5
0	2½	2½	0	0	2½	0	0	5	5	5	5	0	5	2½
5	5	0	5	5	5	5	5	2½	0	0	2½	5	2½	0

Rotation

10	1	8	15	14	11	3	12	5	9	6	13	7	4	2
5	2½	0	0	0	2½	5	2½	0	5	0	2½	0	5	0
2½	5	5	2½	5	0	0	5	5	0	2½	5	5	0	5
0	0	2½	5	2½	5	2½	0	2½	2½	5	0	2½	2½	2½

CYCLE III

Rotation

5	1	14	12	2	11	6	4	9	15	7	3	8	10	13
2½	2½	0	5	0	5	2½	2½	0	0	0	2½	2½	2½	0
5	5	5	0	5	2½	0	0	2½	5	5	5	0	5	2½
0	0	2½	2½	2½	0	5	5	5	2½	2½	0	5	0	5

Rotation

11	13	8	3	12	4	2	6	10	5	7	1	14	15	9
5	0	5	2½	5	5	2½	2½	2½	0	5	2½	5	0	2½
2½	5	0	0	2½	0	0	0	0	2½	0	5	2½	5	0
0	2½	2½	5	0	2½	5	5	5	5	2½	0	0	2½	5

CYCLE IV

Rotation

13	6	3	1	4	2	8	5	10	14	12	9	7	11	15
0	2½	5	2½	2½	5	0	0	5	5	0	2½	0	2½	2½
2½	5	0	5	0	0	5	5	0	2½	2½	5	5	0	0
5	0	2½	0	5	2½	2½	2½	2½	0	5	0	2½	5	5

Rotation

15	1	9	10	13	12	6	7	3	2	4	11	8	5	14
0	0	2½	2½	0	0	5	2½	2½	0	0	2½	0	0	2½
5	5	0	5	5	2½	0	5	0	5	2½	0	2½	2½	5
2½	2½	5	0	2½	5	2½	0	5	2½	5	5	5	5	0

CYCLE V

Rotation

1	8	15	5	2	3	12	9	6	7	14	4	11	10	13
0	0	5	5	2½	0	0	0	5	2½	0	2½	2½	2½	0
5	2½	2½	2½	5	2½	5	2½	2½	0	5	5	5	5	2½
2½	5	0	0	0	5	2½	5	0	5	2½	0	0	0	5

Rotation

1	7	14	13	8	15	11	9	4	3	10	12	5	2	6
2½	0	0	0	0	5	2½	5	5	5	5	2½	2½	2½	0
5	5	2½	2½	2½	2½	5	0	2½	0	0	0	0	5	5
0	2½	5	5	5	0	0	2½	0	2½	2½	5	5	0	2½

ANTI-EROSION EXPERIMENT.

To be laid down on land of uniform, unidirectional slope.

Objects.

1. To compare the effect of ploughing and hand-cultivation on loss of fertility.
2. To assess the relative merits of the following treatments as anti-erosion measures applicable to native farming.

Treatments.

1. Contour hedges.
2. Contour strips of sweet potatoes on bunds.
3. Contour strips of unopened land.
4. Natural terracing by piling up clearing trash.
5. Control.

Lay-out.

There are ten treatments in each of the five randomized blocks. Plots 11 yards wide and 44 yards long, the long axis down the slope with anti-erosion treatments at about each 2.5 ft. drop.

Rotation.

1st Year.—Prepare land.
Cotton.

2nd Year.—Eleusine.
Cotton.

3rd Year.—Groundnuts.
Sorghum.

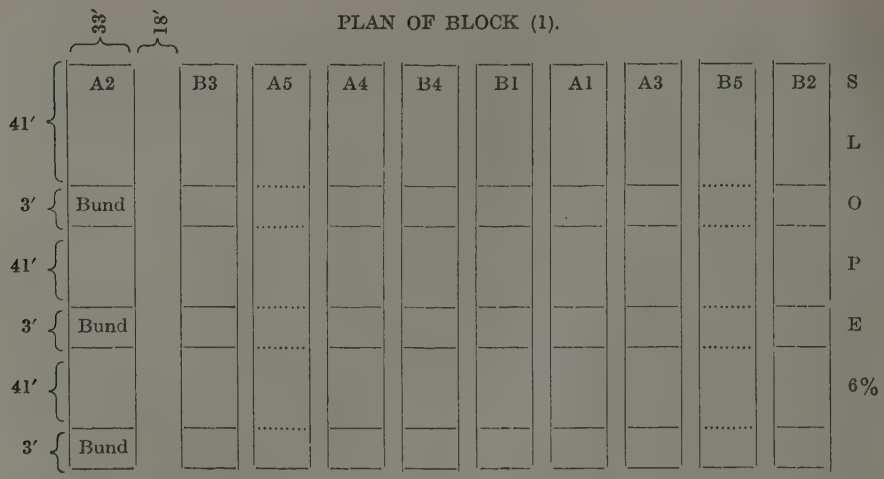
4th Year.—Green manure.

5th Year.—Green manure.

ACKNOWLEDGMENTS.

The original plan was drawn up after the views of Agricultural Officers and Technical Officers in Uganda had been obtained. It remains to thank the Agricultural Adviser to the Secretary of State (Sir Frank Stockdale) and Mr. Yates, of the Rothamsted Statistical Department, for their valuable advice, and Mr. H. R. Hosking, of the Uganda Department, for statistical assistance in the final lay-out.

PLAN OF BLOCK (1).



A. Ploughed.

B. Hand cultivated.

1. Lemon-grass contour hedges,
2. Sweet potato contour bunds,
3. Contour strips of uncultivated land,
4. Trash bunds,
5. Control.

—all occupying 1 yard base.

Plots to be harvested in thirds. The space between dotted lines on controls not to be harvested.

Reserve Fodder Plants

In response to a request by Mr. E. W. Hodgson, of Athi River, we reprint the following article from *Farming in South Africa*, 1931, 6, p. 176.

The Conservator of Forests, Nairobi, generally has seed of Saltbush for sale. Small plots of Spineless Cactus are established in various parts of Kenya, but we know of no large local source of supply:

Oldman Saltbush and Spineless Cactus have consistently proved valuable fodder plants in localities where the rainfall is inadequate for the production of a sufficient quantity and variety of stock feed to last throughout the year.

For the best results, lands intended for Saltbush and Spineless Cactus should be well ploughed and, to prevent damage to the young plants, should be fenced.

SALTBUSH.

The Saltbush succeeds in a great variety of soils not suitable for other crops, but for its best development alkaline and limy soils are required.

Plants may be established from cuttings or raised from seed, by sowing in seedbeds and then transplanting the seedlings. Sow the seed during the spring or autumn in well-prepared, small seedbeds or in tins. Cover lightly with fine soil, and keep moist by watering with a watering-can giving a fine spray. To check evaporation cover lightly with grass or even with sand. When the plants are from three to five inches in height they may be transplanted, and should be placed about four inches apart each way. The original sowing may also be done very lightly, to obviate the necessity of transplanting. The seedlings are ready to be transplanted in their permanent positions when they are from nine to twelve inches in height. Seed may also be sown on harrowed land and then be rolled or harrowed in again. This method gives good results when rainy weather is likely to prevail for a few weeks.

Cuttings from well-developed branches a quarter of an inch or more in thickness may be planted in beds or tins containing light soil, or direct into furrows on the land.

Transplanting of seedlings or rooted cuttings is generally done during the early or latter part of the rainy season; cut off half of the top part of the plant before transplanting. Mid-season plantings are frequently at the mercy of weed growth and hot, dry spells. Before planting, plough and harrow the land in the ordinary way. Set the plants in rows five feet apart and the plants three feet apart in the rows. To ensure the best development the soil should be cultivated until the plants overshadow any weeds and keep them well in check. Keep stock out of the plantation until the second year. Feed judiciously, and do not overgraze, as then the plants tend to produce a very woody growth.

From one pound of seed sufficient seedlings may be raised for the planting of two to three acres.

SPINELESS CACTUS.

Spineless Cactus should be propagated vegetatively by means of "leaves". Plants raised from seed are usually very weak and frequently very spiny.

The most hardy varieties are *Eusicaulis*, *Sonoma*, and Hardybred. Planting of "leaves" should be done from September to November. To prevent rotting it is advisable to wilt the "leaves" for two or three weeks before planting, and they may be planted upright with the broken-off end one-half to one-third in the soil, or they may be laid down flat under the weight of a stone or a clod of earth. It would appear that the method of planting has little effect on the ultimate growth made by the plants, but on the whole the latter method is preferable. The plants may be spaced in rows 15 by 20 feet apart and 3 to 4 feet apart in the rows. Approximately 1,000 "leaves" will suffice for an acre.

Spineless Cactus plants respond remarkably well to good treatment. Cultivating between the rows once or twice a year is beneficial, and danger of fire owing to weed growth is removed. Plantations that have made good growth for five or six years, or from which a considerable quantity of "leaves" has been removed, benefit considerably from an occasional application of farmyard or kraal manure at the rate of two and a half to three tons per acre.

Local conditions will determine as to whether "leaves" should be cut and fed, or whether stock should have access to the plants. At all events, stock should not be turned into

the plantation until it is three or four years old, and when this is permitted they should not be left for more than three or four hours daily during the winter and early summer.

When the "leaves" are cut up in a chaff-cutter or otherwise, more will be consumed than when fed in most other ways. When fed cut, an animal should not receive more than 50 to 60 lb. of cactus a day.

Planting material of a Spineless Cactus, reported to be entirely free from spines or anything injurious to stock, may be obtained from Mr. E. W. Hodgson, P.O. Athi River, Kenya Colony, at the following prices: 10 cents per slab on the farm, 15 cents packed in bags f.o.r., or 20 cents packed in crates f.o.r. Athi River. The last method of packing is to be preferred, since damage often occurs on the railway to material packed in bags.

The Close Planting of Groundnuts

By W. C. CLARKE, *Agricultural Assistant, Department of Agriculture, Tanganyika Territory.*

In the Mwanza District of the Lake Province of Tanganyika groundnuts are planted by natives mostly on low ridges and mixed with other crops, chiefly cereals, such as maize and millet. These ridges are 5 feet apart, and usually follow the contour. Consequently this method of cultivation is most effective in checking soil erosion.

The Msukuma native usually plants only one row of groundnuts on these ridges, with the result that his yield of groundnuts is low and the small crop of maize or millet does not compensate him for the waste of land. At Ukiriguru Seed Farm it has been found found that by planting native groundnuts two rows per ridge, and each seed spaced 12 inches apart in the row, yields of 900 lb. of shelled nuts per acre are obtainable in a normal season. The groundnuts planted in the manner described do not appear to be over-cramped, but trail down into the furrow and utilize the available space between the ridges. This closer spacing does not preclude the interplanting of early maturing maize such as the native uses. By the end of March or earlier the maize can be harvested, and the groundnuts thus allowed to develop.

Experiments at Ukiriguru in the spacing of groundnuts have shown significant results in reducing the incidence of rosette diseases where close spacing has been adopted. Considering that this disease alone is estimated to be capable of reducing the groundnut yields of native cultivators by 50 per cent, the importance of close spacing cannot be over-emphasized.

The seed rates required for the two methods are approximately as follows:—

Ukiriguru method: 30 lb. per acre.

Native method: 12 lb. per acre.

One of the arguments put forward by the African against closer spacing is that he has insufficient seed.

Upright varieties of groundnuts, such as Virginia Bunch, require still closer spacing, and at Ukiriguru three rows per ridge and spaced 8 inches in the row has been very successful.

Construction of Farm Buildings

The Use of Sun-dried Brick

By H. W. LANE, *Assoc.M.Inst.C.E., Senior Assistant Engineer, Public Works Department, Kenya Colony.*

There comes a time when the settler, more especially the married settler, is obliged to consider the replacement of those temporary buildings, which he hastily erected during the first months of occupation of his property, by something more permanent.

Undoubtedly buildings of burnt brick or stone are preferable, but it may be that on his farm there is no suitable clay, nor stone, and in that case he has to think of other alternatives.

One alternative is the use of soil, either in the form of *pisé-de-terre*, or by converting it into sun-dried bricks. *Pisé-de-terre* construction is the damping and ramming of selected soil between boards placed apart at a distance equal to the width of the proposed wall. This method may have been successful in other countries, but, in the experience of the writer, it has often given disappointing results in East Africa. After a week or two large cracks develop; even a partition wall may part company with its adjacent, external wall. So much depends upon the type of soil, the degree of dampness, and the hardness to which it is rammed. A soil which is suitable for *pisé-de-terre* construction is certainly suitable for the making of sun-dried bricks, and even though the latter may involve a more lengthy process, they are much more likely to produce better results. Contraction and warping take place during the drying of the brick and not in the walls.

Most settlers are conversant with the making of an earth brick, but there are a few points which might be borne in mind. The dry season should be chosen for moulding the bricks. Too large a brick, which will take long in drying, should not be attempted; 9⅞ in. x 4¾ in. x 3 in. is a convenient size for the mould. The mixture should not be too sloppy, which state tends to increased cracking during drying. The wet bricks should be protected from the direct rays of the sun until semi-dry and able to be handled, then stacked under a grass roof (no sides) with a space of about ¾ in. round each brick to permit the circulation of air.

In the first instance, experiments on the different types of soil to be found on the farm should be made, and, except in the more sandy districts, top-soil is not generally the best.

The cost of these experiments should be negligible. If they do not produce a hard, compact brick, the idea of building in untreated earth had better be abandoned. Let us assume, however, that a good earth brick has been obtained.

The site of the new house is often decided long before building operations are thought of. It should be ensured that the site is capable of being drained, for water lying about any building is likely to cause settlement sooner or later. Probably it has also been decided that the front of the house will face the best view, but it is advisable to remember that there is not only the view to be considered. A front veranda facing the prevailing wind will not be much used in leisure hours; it is an advantage that the morning sun shines into the bedrooms and the bathroom; window openings facing the hot afternoon sun tend to heat rooms unless

protected by a veranda, and they should therefore be reduced to a minimum; and, in the warmer districts, it is better that the house be only one room thick, with openings on either side, in order that draughts may be obtained.

It is advisable to decide on the sizes of the various rooms and stores by taking measurements of actual examples, which seem to suit requirements, from some neighbour's house. Small rooms are undesirable, but, on the other hand, very large rooms add to the cost, as they involve a greater floor area, a greater ceiling area, and a greater roof area.

The lay-out having been decided upon and a good stock of bricks on hand, actual building is the next consideration. If the sun-dried brick house is to last, its foundations should be just as solid as for one of brick or stone. Settlement and cracking of the walls should be prevented. The depth of excavation for the wall foundations should be not less than 12 inches below ground level at any point. If the ground slopes much, "steps" can be made in the floor of the excavation. The solid base is usually of concrete, 4 inches to 6 inches thick, the width being that of the wall thickness, plus 3 inches on either side, to obtain a better spreading effect. The weakest mixture permissible for this concrete is one part cement, four parts of clean sand, and seven parts of broken stone. The sand should be free from loam or organic matter, and washed if necessary. It is most important in any concrete work that the sand be clean. The stone should be broken to a size that will pass through a ring 1½ inches in diameter, that is, about the size of a hen's egg. It is not a disadvantage also to include stone of a size less than this.

The ingredients for the concrete should be mixed thoroughly in a dry state before water is added. After water is added, and the whole turned over at least twice, the mixture should be laid in the excavation and not left long upon the mixing platform. It should be tamped until it is compact, and kept covered, and damp, for at least seven days. Upon this level layer of concrete the sun-dried brick walls are built.

The thickness of the external walls should be not less than two bricks thick, that is, about 18 inches, while partition walls can be 1½ bricks thick, or about 14 inches. The height of the walls, for the thickness given, could be as much as 12 feet. Greater thicknesses are required for greater heights. The bricks are laid in a mud mortar which, on drying, cracks as little as possible. In a building as described it is difficult to keep termites from the floors, and these are thus best made of concrete. It is possible, however, to prevent them entering the walls above, and devouring window-frames and woodwork in the roof, by placing an ant-course, say, 2 inches above the floor level. The cheapest ant-course is one of three-ply ruberoid roofing, or similar material, laid lengthwise on top of one of the courses of brickwork, with joints overlapped, and held together with the solution generally provided with this material. The ant-course should, at least, be flush with the walls on either side.

The concrete floor should be above ground level at any point, and laid on a base of rammed stones or murram. A thickness of 3½ inches is sufficient, but a wearing surface of cement plaster, of one part cement to two parts sand is necessary, which should be added within a few hours after laying the concrete base. If the base becomes dry the, plaster will not adhere to it. Smoothness can be obtained by using a steel "float" in the final working up of the plaster. The plaster should

be covered when hard, and kept wet for seven days. If the floor be laid after the roof is erected, no covering is required, but dampness is still essential for the proper curing of the cement plaster. When the concrete dries, contraction cracks may occur, especially against the walls. In consequence, it is possible for termites to rise through these cracks and damage articles lying on the floors; a daily inspection is advisable in districts where termites are abundant. A more costly construction is necessary if termites are to be excluded entirely. It might be added that a particularly favourite place for termites to enter a wall is below the vertical member of a door frame. The ant-course should be bent under the bottom of these frames, so that the legs of the frame rest upon it. Iron dowels, fixing the bottom of a door frame to a concrete floor, should not be used.

The building of sun-dried brick walls should also be undertaken in the dry season if possible, as rain upon uncovered walls of this nature can do much damage. it is advisable to have some form of covering material at hand, even if only grass, though sheets of galvanized iron are much better. If the roof is to be of iron, no additional expense is incurred, as the sheets may be used temporarily as a cover.

The roof of the building must be well anchored. Anchor bolts of, say, 3/8 in. round iron, of a length equal to one and a half times the wall thickness, spaced at 6-foot centres, and each having an anchor plate about 4 in. square of 1/4 in. thick iron, should be built into the wall during the laying of the top courses of the brickwork. They should project 3 inches above the final top of the wall and be threaded for the last 1 1/2 inches. A skimming coat of one part cement to six parts of sand should be laid across the wall width, and a wall plate of, say, 4 in. x 2 in. timber, laid flat, placed thereon as a support for the ceiling joists and rafters. This plate should be drilled so that the anchor bolts pass through it. It is kept in position by a nut and washer at each anchor bolt.

In order to expose as little wall surface to the rain as possible, roofs are best of the hip type for this class of construction. The roof should project well beyond the outer faces of the walls, from 2 to 3 feet, if verandas are not provided. The external and internal appearance of the walls can be improved by the addition of a mud plaster laid in thin layers, each layer being allowed to dry before the next is applied. The addition of sand to a plaster of this description decreases the tendency to crack. It is not advisable to apply a cement mortar to an earth wall unless some sort of "key" is provided. The cheapest form of "key" is wire netting, say, 1 1/2 in. mesh, laid against the wall and kept in place by binding wire laid in the wall during the building of the brickwork. A cement plaster of this nature makes a wall practically weatherproof, and need not be of a greater strength than one part cement to six parts of sand, provided that the sand is clean and that the plaster is applied immediately after mixing.

Sun-dried bricks can also be used in the construction of garages, workshops, and similar buildings. They are not suitable for stores containing mealie meal, gunnies, or other articles beloved by rats, nor for native quarters, as the earth walls tend to harbour vermin.

If some care is taken during construction, and rain water led away from the footings of walls by adequate drainage, there is no reason why a house made of sun-dried bricks should not serve for many years and provide a comfortable home.

Composts and Composting

By V. A. BECKLEY, *M.C., M.A., A.I.C., Senior Agricultural Chemist, Department of Agriculture, Kenya Colony.*

That humus, organic matter, is essential for the maintenance of soil fertility in the tropics is now generally accepted. The simplest method of adding organic matter to the soil, by green manuring, is unreliable. If conditions are just right, if the green manure is turned under at the correct stage, then the results are satisfactory. But usually these requirements are not satisfied; perhaps decomposition has been delayed and the seed is planted while decomposition is still actively progressing, when either germination is poor or the growth is retarded; perhaps heavy rain has delayed planting so that, when the seeds germinate, most of the soluble plant nutrients, especially nitrogen, have been leached down beyond the feeding zone of the seedlings, and so the crop does not benefit fully. With permanent crops, however, there is a benefit from green manuring and cover crops, provided the material is not turned under too mature at the beginning of the dry season. This view is held in spite of Howard's insistence that the soil must not be called upon to do two jobs at the same time.[1]

The usual source of bulky organic manures is the dung and bedding of domestic animals; in East Africa usually the undecomposed or only partly decomposed accumulations in stock *bomas* are used. In very few cases is this supply sufficient to meet the needs. In the main coffee areas of Kenya certainly the supply of dung is insufficient. To satisfy the need, methods of composting waste materials, such as straw, have been developed for converting them into useful and readily available manures.

The first of these methods is the "Adco" process, which was worked out by Richard and Hutchinson at Rothamsted. In short, the process consists in composting straw and similar wastes with a source of available nitrogen and some basic material. A very valuable artificial farmyard manure is produced by this method. A modification was developed at the Scott Agricultural Laboratories, suitable for use in East Africa, and was described in 1930.[2]

Appreciable quantities of manure were produced by this method, but cases of the stacks firing and of uneven decomposition were reported. Further investigation showed that this was due to the difficulty of wetting the stack evenly. In the early stages very high temperatures were reached in the stack. Those zones which were not saturated dried out and decomposition ceased or, in exceptional cases, caught fire, just as a damp hay stack will fire. It was observed that partially fermented straw wets more evenly than fresh straw, so a technique was developed involving restacking after a preliminary fermentation of a fortnight to a month.

About this time Howard's book, *The Waste Products of Agriculture,* appeared, describing the Indore technique. This publication has probably done more to arouse interest in the composting of waste materials into good manures than any other two or three. Very shortly after its appearance in Kenya there was more compost being made by the Indore technique than had been made by any other methods.

It is not intended to give in close detail the Indore process. It was really evolved to meet the needs of the Indian peasant

cultivator in the parts where fuel is scarce and dung cakes are used for fuel. The mixed farm wastes are used as bedding for the cattle, becoming crushed, coated with dung, and impregnated with urine. Daily the bedding is mixed and removed, some of the dung being reserved from the manufacture of fuel cakes for the process of composting. Any earth moistened with urine is carefully removed and used. The soiled bedding is placed in the pits in thin layers, sprinkled with dry urine earth and a slurry made of carefully laid down quantities of fresh dung, urine earth, wood ashes and material from an older pit till apparently evenly wetted. More material from an older pit is also scattered over each layer to obtain even inoculation of the material with the appropriate decomposing microbes. Great care is taken not to compact the heaps. Adequate water is added. At definite intervals the heap is watered and turned. After 90 days the material is ready for application to the fields.

There are several points of interest in this method. In every case a mixture of wastes is used. When composting a single waste, such as straw, a number of difficulties are encountered, principally that of uneven decomposition. Mixed wastes, especially when well mixed, decompose very regularly. Uneven wetting, which was such a difficulty in the earlier experiments here, has been obviated by using all the wastes as bedding and by the use of a slurry of fresh cattle dung. Water is not held on smooth, shiny stems. The dung, however, coats them very evenly, and also provides a nidus for the necessary microbes.

The process is aerobic throughout. Very great care is taken not to compact the heap and so reduce aeration; much less water is therefore used; the heap is not soaked but is merely moist. Very high temperatures are reached—the writer has recorded over 70° C. (160° F.)—which effectively destroy any insects or fungal disease spores. Not only after the initial stacking, but after each of the turns, the temperature rises.

Inoculation of the heap from older heaps ensures an even and sure distribution of the microbes required to perform the decomposition and bring about the necessary changes. Also, continued cross-inoculations develop a more virile microbial flora, which is able to effect the decomposition more rapidly.

In the Indore system a very large proportion of inorganic matter, mainly in the form of soil, has been used. Howard[1] quotes a series of analyses in which the ash content of the final product varies from 67 per cent to nearly 82 per cent, and "organic matter", partly water, from 19.7 per cent to 34 per cent. On a peasant holding of a few acres, where the material has not to be carried any distance, this is of little importance, but on a large farm of, say, 500 acres, transport costs of the final product must be taken into account. As little soil as possible should be moved. One of the main functions of the soil is to supply bases to keep the reaction of the heap correct. The Indore soil contains about 2 per cent of free calcium carbonate. Those in East Africa who have been closely following the Indore technique, using quantities of soil in producing their composts, are defeating the main object aimed at. Most, if not all, of the soils are acid, and thus are mere diluents. There is no need for an ash content of 80 to 85 per cent. Absolutely pure and organic wastes can be, and have been, used to give a very fine compost.

It must be remembered that the two methods, described shortly above, have been worked out on experimental stations, and, in the case of the latter, for

special conditions. For convenience in working out the details, a number of conveniences will be installed, the cost of which will not be taken into account in working out the cost of producing the manure. For example, water will be laid on to the composting pits; on the farm, more often than not, water has to be carted. We should regard then the techniques developed on an experimental station as forming basal systems which should be modified to meet the conditions and needs of each farm, even though the final product may not be so perfect a form of manure. Usually the cost of production will be reduced. Cases are known to the writer where, following the Indore technique, compost is produced at Sh. 6 per ton; others where, using a modification suited to the conditions of the plantation, a very usable compost is produced for about Sh. 2 per ton. Assuming an expenditure of Sh. 12 per acre, which would a farmer prefer—2 tons of Indore compost or 6 tons of the good usable compost per acre?

What are the basal factors in compost production discovered during the past few years?

(1) A certain amount of nitrogen is needed. By using a small amount of inorganic nitrogen it is possible to rot down even such poor wastes as straw to a good manure. Less mature wastes contain more nitrogen, so less need be added. It is possible in time to rot down any waste without adding any extra nitrogen.

(2) It is difficult to wet plant wastes evenly, but a dung slurry or a preliminary fermentation will give a colloidal coating to each piece, making even wetting easy.

(3) The microbes responsible for the decomposition work best in air, and can be made much more virile by cross-inoculation.

(4) The mass must not be saturated. This tends to cut off air, slows down decomposition, and makes the final product difficult to distribute. When maintained just moist, decomposition is rapid, high temperatures are reached which destroy pests and diseases, and the final product is loose and powdery, very easily distributed.

(5) Turning at intervals keeps the mass well aerated, permits of the desired inoculations, and, above all, evenly distributes the material in various stages of decomposition throughout the heap.

(6) The addition of some basic material is beneficial. In the Indore technique this is provided by the soil containing much lime and wood ash. In East Africa, wood ash and a little cheap basic phosphate—bone meal, ground rock phosphate, etc.—will supply the need. The use of the latter raises the phosphate content and so improves the nutrient balance of the compost.

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(To be continued.)

Helopeltis Bug

By W. V. HARRIS, *M.Sc., F.R.E.S., F.Z.S., Entomologist, Department of Agriculture, Tanganyika Territory.*

The Helopeltis bug, *Helopeltis bergrothi,* has been known in Tanganyika for many years. Morstatt[6] recorded it as a pest of cinchona, cacao, cotton and camphor, but not as of any importance. Since 1922 it has been collected at intervals on cotton in various parts of the Territory, but never in numbers. In 1931 it appeared on tea in Tukuyu.[1] In 1935 a number of cases of injury to cotton were reported, particularly in the Morogoro and Usambara districts, and Helopeltis bug was kept under observation as a minor pest.[2] During 1936 Helopeltis has appeared as a serious pest of a number of plants other than cotton, and the attention of nurserymen and gardeners generally is now drawn to the bug.

HOST PLANTS.

Helopeltis has a wide range of food plants. Among those of importance or likely to be attacked in this Territory are the following:—

Economic.—Tea, cacao, cotton, cinchona.

Nursery or Ornamental.—Avocado, mango, guava, *Annona,* sapodilla, *Eugenia,* kapok, potato-creeper and other ornamental solanums, *Acalypha, Datura, Bixa.*

Alternative Hosts.—Sweet potato, castor oil; also *Centrosema, Leucaena glauca, Indigofera,* and a number of other legumes used as cover crops or for green manuring.

NATURE OF INJURY.

The injury done to the host plant by Helopeltis has been described in detail for cotton by Steyaert and Vridagh[7] and Leroy,[5] and for tea by Leach and Smee.[3] It is more or less similar for all plants attacked, and consists of two main types:

(*a*) *On the Foliage.*—Numerous angular spots appear, first of all black, later becoming brown and more or less transparent as they dry out. Leaves severely attacked when young crumple, and the plant develops a bunching growth. Superficially these spots resemble those caused by bacteria—for example, angular leaf-spot in cotton—but with the important difference that fresh Helopeltis spots are never water-soaked. (Figs. 1 and 2.)

(*b*) *On the Stems and Branches.*—First discoloured patches appear, which after a short time dry out and form rough, corky lesions. These, if large, split and form canker-like growths as the stem becomes woody. They are to be distinguished from bacterial lesions by the fact that, until they begin to dry out, they only affect the outer layers of the stem. (Fig. 3.)

The result of such injury in nursery plants is a serious setback in growth, the development of a witch-broom type of branching, and, in severe cases, the death of the plant. Avocado plants are very susceptible until they reach a height of about four feet. Infestation of kapok nurseries will seriously interfere with the planting programme. Seedling guavas, mangoes, and other fruit trees may be killed, while the propagation by cuttings of the ornamentals listed above is rendered difficult.

Tea plants are less susceptible in the field than in the nursery, but even so the importance of a pest that may attack the tips of the branches of bushes in the open plantation will be readily understood.

FIG. 1
Helopeltis injury to Avocado—leaf spot

FIG. 2
Malformation of young Guava plant due to Helopeltis

FIG. 3
Helopeltis lesions on stem of young Avocado

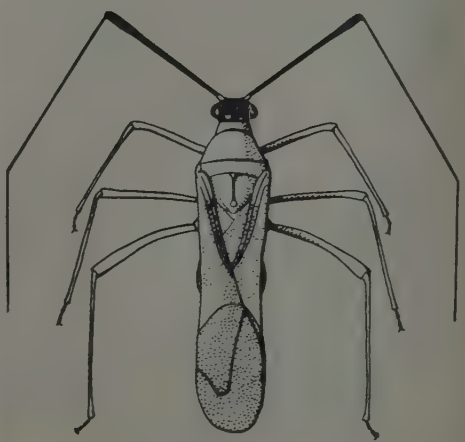

FIG. 4
Adult Helopeltis bug

One of the difficulties in spotting Helopeltis attack is that in mild infestations the adult insect is difficult to find, and may be overlooked altogether. A relatively few insects will produce serious injury, as, for example, in a cotton field which, in 1936, produced practically no crop, although the average number of Helopeltis nymphs and adults was never more than 1.5 per plant.

Description.

The adult Helopeltis bug is from 7 to 9 mm. in length. (Fig. 4.) The antennæ and legs are long and slender, and the body narrow, giving the insect a delicate appearance, and accounting for the name of Tea Mosquito, given to this genus in the East. The head and antennæ are black, the thorax and abdomen bright red or orange, with the legs of the same colour, and the wings mainly black with some red markings. The most distinctive point about the insect is a spine-like projection, 2 mm. long, on the back of the thorax, between the points of attachment of the wings. The nymphs are slender and wingless. They are pale yellow in colour, with red markings and red eyes. After the first four days the distinctive spine is present on the back, as in the adults.

Life History.

The eggs are buried in the tissues of a host plant and are consequently difficult to locate. The softer tissues at the ends of branches, the growing point of the stem, and the veins of young leaves are chosen. A preference for young plants is shown. Steyaert and Vrydagh[7] state that a female can lay at least thirty eggs. The incubation period, according to Lean[4] is from 11 to 16 days, with an average of 12 to 13.

The nymphs feed by puncturing the cells of the young tissues of the host, and after passing through a series of five moults, become adult about 18 days after hatching.

The adult female begins to lay eggs from 4 to 7 days after the final moult, thus giving a life cycle complete in roughly 35 days.

Control.

Helopeltis occurring in nurseries and gardens can be controlled by dusting with finely powdered pyrethrum. It has been found that by mixing fine slaked lime with the pyrethrum, in the proportion of two to one, a dust is obtained that can be applied liberally yet economically, and is thus suitable for application by native labour. In this case a robust dust-gun is essential, and one of the rotary blower type has given good results.

Cage experiments with adult Helopeltis on young avocado plants, using the 1-2 pyrethrum-lime dust, gave a 100 per cent kill after a light dusting (average number of Helopeltis per cage, 25). Feeble movements took place in a number of bugs up to three hours after dusting, but none recovered.

A mixed nursery, about one and a half acres in extent and heavily infested with Helopeltis, was then dusted. Twenty-four pounds of the prepared dust were used, but as about one-third of the area was under citrus, which was not dusted, the rate was roughly 25 lb. per acre of dust, or 8 lb. per acre of pyrethrum. The rapidity of recovery of the more susceptible plants was one striking result. No adult Helopeltis were found five days later. A number of young Helopeltis were found on the seventh day, together with slight injury to avocado plants. A second dusting of six pounds of the mixture was given eighteen days later, on the plants on which nymphs were found, i.e. avocado, potato-creeper, and *Acalypha*.

The necessity for a second dusting is explained by the fact that the eggs are out of reach of the pyrethrum powder, and thus nymphs will appear from them up to sixteen days after the first application has killed off the adults and nymphs. The second dusting should be given from sixteen to nineteen days after the first. Additional dusting will be necessitated by reinfection from outside sources.

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The Introduction of Sugar Cane Varieties

By H. H. STOREY, *M.A., Ph.D., Plant Pathologist, East African Agricultural Research Station, Amani, Tanganyika Territory.*

The Central Quarantine Station at Amani has now been in operation for two and a half years. Established for the quarantine of imported plants of any kind that might carry a dangerous pest or disease, its activities have hitherto been mainly concerned with the introduction of sugar cane varieties. An account of its method of working and the introductions accomplished may be of interest.

In the first place, however, it will be well to remind readers why this irksome and prolonged procedure of quarantine is imposed on the importer of a new variety of sugar cane. The sugar industries of the world have learnt to their cost that diseases and pests may be carried over great distances unsuspected in setts of sugar cane. Before quarantine measures were imposed an extensive distribution of setts of desirable varieties had taken place; as a consequence, mosaic disease, for instance, was carried from the East to almost every sugar-producing country of the world. The result was disastrous to many countries. The industry of Louisiana suffered almost a complete eclipse, from which it only slowly recovered as the plant breeder provided the means of control. East Africa, as is well known, did not escape the introduction of mosaic disease. Many other serious cane diseases, however, still occur only in limited areas of the world, and, when the dangers of their distribution in the trail of mosaic were recognized, some countries imposed a complete prohibition upon the import of any living cane. Later, however, it became evident that prohibition imposed too severe a handicap, depriving the country of the use of the new and improved varieties that were being turned out in increasing numbers by many cane-breeding stations. So the compromise of quarantine was generally adopted.

It must be emphasized that quarantine is a compromise. Although it removes most of the risks involved in importation, it can never be infallible. It can intercept diseases that are known; but there is always a danger that a disease, hitherto unrecognized and perhaps producing no symptoms on the variety quarantined, might be passed out to the cane fields,

where it might play havoc with varieties already established. Consequently import, even through quarantine, should be cut down to a minimum. Only varieties that offer a substantial prospect of improving on those already established should be imported. The importation into East Africa of one variety on more than one occasion is inexcusable.

The method of quarantine is to grow the imported plants isolated in small greenhouses. Here they are maintained under close observation; and, being isolated from other importations and from the local plant population, they can be destroyed should a disease or pest appear. The greenhouses at Amani, erected with funds provided from the Colonial Development Fund, are of the most modern design, and permit of the maximum precautions against the accidental "escape" of an imported disease or pest. But greenhouses must have ventilation; the finest gauze that will permit ventilation cannot prevent the escape of the smallest insects; so that, once again, it must be recognized that quarantine is a compromise and cannot give absolute security.

Let me now deal with the procedure that has been adopted for the introduction of sugar cane varieties. A planter desiring a particular variety from overseas should write to his Department of Agriculture. Then he must wait, with such patience as he can muster, for a matter of two years. Meanwhile, the Department will pass the request to Amani; Amani will obtain the variety from the most advantageous source overseas, and grow it in the quarantine houses. When the material has been passed as suitable for release, the original applicant will be informed. Only a small number of setts will now be available—generally between 50 and 100—and these will be issued at a price, to cover the expenses of quarantine, of 50 cents each.

Hitherto it has been the custom, after a variety has been released from quarantine, to multiply it in the open at Amani. But the Amani climate is not well suited to rapid growth of cane, and on a sugar estate multiplication should be more rapid. For this reason the policy has been changed; but for the same reason the quantity of setts available for distribution from Amani will be much smaller than heretofore, and prices have been increased.

The varieties listed below are those that have already been passed through quarantine and multiplied at Amani. Considerable quantities of most of them are available for sale at a price of 15 cents a cutting. The varieties are classed according to their resistance to mosaic disease, which is now a major factor in several of the important sugar-growing districts of East Africa. Even where mosaic disease does not at present occur, the grower would be well advised to give preference to the mosaic-resistant varieties. Where only a narrow land barrier divides the infected from the free districts, it can be only a matter of time before the disease passes over, however stringent the precautions taken to avoid it.

Resistant, or believed to be resistant, to mosaic disease:—

Variety.	*Country of Origin.*
Mayaguez 3 imp 702 ...	... Porto Rico.
Mayaguez 42 ...	... Porto Rico.
B. 3172	... Barbados.
B. 3254	... Barbados.
B. 3257	... Barbados.

Susceptible to mosaic:—

Variety.	*Country of Origin.*
H.M. 320	... India.
H.M. 606	... India.
Ba 11569	... Barbados.
B. 726	... Barbados.
B. 891	... Barbados.
B. 2935	... Barbados.
B. 3013	... Barbados.

A Study of Methods of Cultivating Sisal in Kenya in Comparison with those used in Tanganyika

By G. W. Lock, *Dip. Agric., N.D.A., Agricultural Officer in Charge of the Sisal Experiment Station, Ngomeni, near Tanga, Tanganyika Territory.*

The system of cultivating sisal in Kenya does not correspond exactly with that ordinarily followed in Tanganyika, and consequently it may be of interest to compare the respective methods of the two principal sisal-producing centres in East Africa. Broadly speaking, the distinction arises through climatic differences, induced chiefly by a wide disparity in altitude. Over 80 per cent of Kenya sisal exports originate from the highlands above 5,000 feet, and it is proposed to describe in most detail sisal-growing in those parts.

Sisal-growing Localities.

The greatest concentration of estates occurs within fifty miles of Nairobi, towards the north and east. Other estates are further inland, near and beyond Nakuru; some are scattered in the plains, and a few are on or near the coast.

As is well known, the highlands enjoy a cool climate during most months of the year. Sisal is planted in areas with an average annual rainfall of 25 to 30 inches (600 to 700 mm.). The seasonal distribution is similar to that ruling in northern Tanganyika, e.g. the main rains during April-May, and the short rains in November. In contrast, the climate of the coastal belt of Tanganyika, where most of the sisal is grown, is tropical, and the rainfall varies from 40 to 60 inches (1,000 to 1,500 mm.) yearly.

Effect of Climate upon Growth.

One of the effects of a cool, dry climate is to retard plant growth. Hence the life-cycle of the sisal plant is prolonged to nine years in the Kenya highlands, and cutting cannot begin until the fourth year from planting, or a year later than in the warmer regions of Tanganyika. Age for age, young sisal in Kenya is smaller, each plant having a compact, ovoid appearance, due to the broad, thick-set leaves curving inwards instead of pointing directly outwards. In all young plantations a narrow brown streak on the outside edges of the leaves was observed, which sometimes persisted in a milder form on the mature plant, especially if it was unthrifty. Most of this brown strip is removed during decortication. The "tucked-in" look of the plant is probably caused by a contraction of the outside edges of the leaves.

Granted favourable soil conditions, highland sisal develops into a massive plant with long heavy leaves and a tall stout bole, which is exaggerated by the fact that the leaf-butts left on after cutting remain fleshy and green for several months. The pole finally produced is thick and strong. By comparison, Tanganyika sisal in general looks a puny, open plant with thin leaves, and for this reason it is hard for the Kenya grower to understand how Tanganyika sisal can yield as well as, or better than, his own.

Soils.

Depending upon its moisture-retaining qualities, in Kenya soil has as much influence upon growth as climate; a reaction seen to a less marked degree in Tanganyika, chiefly on account of the heavier rainfall. In Kenya, sisal is mainly grown on three soil types, described by Milne as follows:—

(i) Red earths, laterized on volcanic rocks.

(ii) Red earths, laterized on basement complex rocks, chiefly gneiss.

(iii) Black or grey clays.

Some sisal in the Rift Valley was growing on a fine volcanic ash. The best sisal was on the red volcanic soils, mainly in the vicinity of Thika, where sisal and coffee can be found growing side by side. That on the clays was usually indifferent, as might be expected. Wherever a pan of concretionary ironstone or "murram" existed near ground level on the red volcanic loams the sisal tended to be stunted. Red earths on gneiss, liable to set hard and in places overlying quartz beds, are the typical soil for estates at lower elevations in the plains. On the coast, sand overlying coral limestone prevails, as in Tanganyika. Both kinds of red soil are prone to sheet erosion, whereas the black clays "swell when wet, increasing run-off, and crack deeply when dry, thus exaggerating the effects of drought." (Milne: *Amani Memoirs,* "A Provisional Soil Map of East Africa.")

Cultivation Methods.

In Kenya the initial clearing of land for sisal plantation is fairly easy on account of the original bush being sparse. As a result there are not many stumps to remove before using mechanical cultivation. After clearing and burning, disc-ploughing by tractors to a depth of 8 or 9 inches is usually the next operation, to be followed later by disc-harrowing. Where a wide spacing of 18 to 22 feet between rows is adopted, one system consists of strip ploughing the virgin land, the width of the strips being increased afterwards as the plants become larger, until finally the whole area has been cultivated. The advantage claimed is that only half the field need be cultivated during the first two years of the life of the plantation. Subsoiling is coming into favour, the subsoiler being worked across the slope in order to minimize soil wash, and the sisal being planted in the rows made by the subsoiler. This practice should encourage deep root systems.

Sucker planting material is used extensively. In the highlands small suckers are chosen, size being some guarantee of their age. In the plains, where rainfall also ranges low, fairly large suckers are preferred because they do not dry out so quickly in the event of a dry spell of weather after planting, and, moreover, they can be planted deeper without harm —an important consideration in windy localities.

After planting, the rows of young sisal are hand weeded two or three times annually and inter-row cultivation with disc-harrow is repeated as often until the sisal is ready to cut. In a well-cared-for plantation in Kenya all suckers are rigorously removed. Once the sisal is established weed competition becomes less important, and growth is not so rank as in Tanganyika; plantations are cleaned once after each cutting, as is the rule in the Territory.

Couch grass is the most difficult to cope with; if left unmolested it will smother young sisal and act as a severe check. Bush growth is almost negligible, partly as a result of stumping and thorough preliminary cultivations, which, in conjunction with restricted weed growth, make the plantations generally look in better order than in Tanganyika. Viewed from a distance, many highland sisal fields resemble, not a sea of bluish-green sisal, but a large green and brown striped sunblind, particularly if in double rows widely spaced.

Soil Moisture Conservation.

Tanganyika sisal-growers have long recognized that heavy weed competition

is inimical to the growth of young sisal, and are obliged to weed new areas frequently each year because the climate makes for rapid development of weeds. The cultivation of sisal is therefore practically nothing but weed control. On the other hand, under the lower rainfall of the Kenya highlands, sisal has to be cultivated, in the full meaning of the word, before any tangible results are obtained. Not only must weeds be suppressed but a good soil tilth must be maintained so as to conserve soil moisture, somewhat analogous to "dry farming". Soil moisture is the precious commoditiy, and whenever it was adequate the sisal was magnificent. For producing a deep friable tilth and breaking up hard subsoils, the native labourer with his hoe is of very limited value. Therefore it is not surprising that Kenya is ahead of Tanganyika in applying mechanical cultivation to sisal. Wide stretches of gently undulating land and reasonable stumping costs have also been contributory factors.

It was generally conceded amongst Kenya growers that ploughing and subsequent cultivation were both essential to foster the growth of sisal. With insufficient tillage, or planting on the simple lines followed in Tanganyika, young sisal remains almost stationary, necessitating a wait of five to six years before it is ready for cutting. The need for the conservation of soil moisture was evident on all types of soils; patches of murram or a clayey subsoil were reflected in the growth of the sisal, which appeared stunted, with chlorotic leaves tending to curl lengthwise and often pink at the tips—all signs of water-strain.

In such areas, good soil management can make an important contribution towards the welfare of the plantation. Deep cultivation is needed first of all as a safeguard against soil erosion and to encourage the infiltration of rain and deep root systems; then a succession of shallow cultivations to keep down weeds, give a tilth, and avoid root damage. On the lighter soils too fine a tilth has short-term benefits, since the uppermost layer of soil consolidates after a heavy downpour of rain, becomes impervious, and has to be disintegrated again. Soils having a clayey texture demand even more cultivation than lighter types, and are best left rough to "weather" on exposure. Although satisfactory yields have been claimed for such land, its suitability for sisal is not very apparent, and the Tanganyika grower usually avoids soils of heavy nature.

In some dry areas young sisal maintained a steady growth and a healthy green colour, whereas the mature plants were inclined to be yellowish and somewhat short, owing to the greater demand made by the larger plants for soil moisture.

Spacing.

In Tanganyika, spacing is largely determined by the straightforward relationship between density of plants and yields. The question of spacing is more involved in Kenya, being bound up with intercultivation, soil moisture, and replanting as well as yields. Probably for these reasons, Kenya growers are not yet unanimous about the optimum spacing for their neighbourhood. Much depends upon the soil and the intensity of cultivation—the better prepared the land, or, expressed differently, the greater the supply of soil moisture, the more plants it appears capable of bearing satisfactorily per unit of area. The removal of suckers must be sustained; the sisal may revert to second grade if the density of plants increases too much.

More than twenty spacings were seen. The widest was 9½ ft. x 5½ ft. (2,060

per hectare), and the closest 8 ft. x 4 ft. x 3 ft. (5,977 per hectare) in the highlands. For single row planting, 12 ft. x 4 ft. (2,240 per hectare) had a long spell of popularity; for the double row system, 12 ft. x 4 ft. x 4 ft. (3,361 per hectare) or 14 ft. x 4 ft. x 4 ft. (2,988 per hectare). However, these spacings have since been thought too generous, and the trend is now towards closer spacing in the row and wider distances between the rows. The density of plants is seldom below 4,000 per hectare in Tanganyika, and is commonly 5,000 per hectare or more, which is possible under a heavier rainfall.

Another aspect of spacing concerns the replanting of poling areas during the last two or three years of the expiring plantation. This practice is successful providing there is ample room between the rows (either single or double) of maturing plants for tractor work and the young plants are not cramped for space. By this means the replanted area enters the production stage again two years earlier, which has its advantages if land is limited. Wide spacing between the rows makes light cutting feasible; it is undoubtedly more attractive for labour.

Cutting.

Close planting in Tanganyika leads to harder cutting, if only to provide access to the plants, though the drastic cutting seen in this Territory is staggering to the Kenya sisal-grower. Leaves above an angle of 45 degrees from the horizontal are seldom cut in Kenya. There, heavy cutting has proved definitely detrimental, and some hold the view, opposed to that in Tanganyika, that it is conducive to early poling. It was also the general belief that leaves above an angle of 45 degress were immature and have a poor fibre percentage. About thirty-five leaves are removed at each cutting; the cutting cycle is from twelve to sixteen months. Counts I made of several strong poling plants showed that a total of 228 leaves had been cut on the average from each plant during its life. The conclusion was being formed by the Kenya sisal-growers that light and frequent cutting resulted in better fibre percentage and yield per hectare.

Topography and Transport.

As mentioned earlier, estates had either level land or gentle slopes (sometimes intersected with valleys left unplanted with sisal) suitable for easy leaf transport and mechanical cultivation. In the highlands, leaf trollies are usually hauled by oxen.

Decortication.

Good leaf in Kenya is heavy and long, with large butt ends. It is notably free from blemishes, and spiny-edged leaves are few. As the thick, fleshy character of the leaf renders rapid clean decortication difficult to attain, decorticating machines are fed lightly and regularly. Some producers turn the leaf on to its concave side before it enters the machine. Because of slow feeding and fibre percentage averaging three per cent, the normal daily output of fibre, which fluctuates between 3 and 4 tons, normally compares unfavourably with those achieved in Tanganyika. Despite easy feeding, the percentage of fibre lost in the waste runs high, and endeavours to improve the extraction result in imperfectly decorticated fibre.

Yields.

It is the practice to replant afresh all maturing areas. Fibre yields are therefore usually reckoned in tons per acre per cycle instead of per hectare per annum as in Tanganyika. Five or six cuts would be made per cycle, yielding (from reasonably good areas) a total of about three tons of fibre per acre. This is equivalent to nearly

30 cwt. per hectare per annum, which rather falls short by half a ton, or occasionally much more, of yields obtained from newly planted areas in Tanganyika, which, however, may decline to the Kenya figure after regeneration by sucker selection. It is interesting to note that the Kenya yields should compare so well, bearing in mind that there are only about half the number of plants per hectare, that much lighter cuts are taken each year, and that extraction is not so efficient; but against this, in Kenya, leaf length and leaf weight are better. Results show that short, spare leaf spells a rise in production costs.

Rehabilitation of Old Areas.

It is not customary to cut poles. Once a field has poled heavily, the straightforward course of destroying the old sisal, ploughing and replanting is usually taken. The idea of regenerating or renovating old areas by selecting suckers is not adopted save on the most favourable soils. Interplanting in the old areas has never been a success anywhere, and was condemned in Kenya. Depreciation of plantations is allowed for at rates from Sh. 25 to Sh. 40 per ton of fibre produced. To bring a new area into bearing at four years old, with the aid of diesel-engined tractors, costs between Sh. 150 to Sh. 180 per hectare, and replanting old areas is about Sh. 30 cheaper. A number of estates remove old sisal boles by means of a pusher blade attachment to the tractor; since many boles are dried out, burning is easy.

This brief review, written after a short visit to the Colony, may help to indicate the salient differences between the Kenya industry and its counterpart in Tanganyika. Out of necessity, Kenya methods are more thorough and they show that sisal responds to superior cultivation. In the coastal plains of Tanganyika, where soil moisture is in plenty, weed control is the main problem. Local conditions have determined the nature of planting methods in both instances. The cultivation of land for sisal in Kenya is facilitated by using diesel tractors, and elaborate though it may seem, and longer though it takes to reach the cutting stage, it is no more costly than the primitive methods used for starting a sisal plantation in Tanganyika by hand labour only.

Acknowledgment is due for assistance and courtesy extended by many sisal-growers in Kenya, and also the Departments of Agriculture of Tanganyika and Kenya, during this visit to the sisal-growing areas of the neighbouring Colony.

Preparation of Hides and Skins in Kenya for Export

With Suggestions for Improving the Standard of Flay and other Qualities in Hides and Skins

By J. H. WARD, *Instructor in Stock, Division of Animal Industry, Department of Agriculture, Kenya Colony.*

INTRODUCTION.

In this article are described simple methods of flaying, fleshing, cleaning and air-drying hides and skins for sale and export to overseas markets.

Hides and skins rank high in the list of animals products of Kenya, and, over several years, have averaged more than 8 per cent of the total value of agricultural exports.

There exists on the European markets an extensive demand for "Mombasas", as local hides are known, but due to their many variations in take-off, cure, and selection they are of average poor quality in comparison with those produced in the United Kingdom, and in consequence they do not command high prices. The majority of local hides emanate from native areas, where most of the cattle are flayed by their original native owners, who lack suitable knives and equipment, and who are usually quite unskilled.

Efforts made by the Division of Animal Industry of the Department of Agriculture during recent years to improve the quality of local hides and skins have met with considerable success in several districts, with gratifying results to the producers in the form of increased prices for correctly prepared shade-dried hides.

During 1935, hides and skins to the value of £179,027 were exported from Kenya. This large amount could have been exceeded considerably if there had been no brands on the butts of the hides, and if all the hides and skins had been properly flayed and prepared.

The value of local hides depends on their freedom from brands, on the care taken in removing them from the carcasses, and the care exercised thereafter in preparing and preserving them for export.

This article is intended to serve as a guide to all producers who may be in doubt as to the best known methods for local application to obtain sound, marketable hides and skins, and an appeal is made to them to remedy as far as possible the faults and defects referred to herein.

DEFINITION AND TRADE TERMS.

By cattle hides, calf skins, sheep and goat skins, the raw product coming from the animals' backs is implied. Roughly, the distinction drawn between hides and skins is that the larger and heavier kinds are termed "hides" and the smaller and lighter "skins".

Preparation or cure means the process undertaken to clean, dry and preserve the raw products for handling and export to the tanneries, after which the tanned products become leather.

A few of the more common trade terms relating to the subject in hand are explained below: —

Grain.—The hair side or outside of the hide or skin.

Corium.—The inner thick layer, or true hide substance.

Fleshing.—The process of removing pieces of muscular tissue and waste after flaying from the flesh side or under side of the hide or skin.

Pattern.—Roughly, the shape of the hide or skin.

Take-off.—The degree of skill and correct method by which the hide or skin is removed from the carcass.

Trim.—Includes the cutting of even edges and treatment of the extremities so that they will lay flat or that their removal will not cause avoidable waste.

Fallen or Casualty Hides are those of animals which have died from disease or accident.

Air-dried or Flint-dried hides and skins are those dried in the atmosphere.

QUALITIES OF HIDES AND SKINS.

(1) A good hide or skin should be of symmetrical pattern or shape, square and regular.
(2) It should be free from decomposition or any taint of decay.
(3) It should be well flayed, possess clean-cut edges, and be free from knife scores and cuts.
(4) It should be free from wounds, scars, brands, skin diseases and injuries to the grain.
(5) It should be clean and free from all dirt, manure, and blood, both on the flesh and grain sides, and the flesh side should have a bright and smooth appearance.
(6) A cured hide or skin should be perfectly dry.

The pattern and trim of the hide is very important, since after it is turned into leather it may be cut into pieces of various shapes and sizes, depending on the particular use to which the leather may be put. The ease with which a hide can be cut up for use, and the proportion of waste resulting, determine its cutting value. For example, a tailor would find it expensive and difficult to cut the pieces which go to make a suit from irregularly shaped pieces of cloth, instead of from a roll of uniform breadth. For the same reason, a boot manufacturer can cut more uppers from a hide of good pattern and trim, with less resultant waste, than from a hide of poor pattern. (Figs. 1 and 2.)

Tanned hides, especially of the larger sizes, are usually cut down the centre from head to tail, and each half is known as a "side". The sides may be sold as whole pieces, or may be cut again into standardized portions, each bearing a trade name. The shoulders, bellies and leg extremities are termed "offal"; not in the sense that these parts are waste, but that they are less valuable than the remaining part of the hide. In whole hides, that portion remaining after cutting off the offal is known as a "butt". The butt is the most valuable portion of the hide. Half a butt, or that portion of a side remaining after cutting off the offal, is termed a "bend".

Thickness and smoothness are qualities needed in hides for certain purposes. A great many hides, mostly intended for cheap boot uppers, upholstery leathers, and bag and case leathers, are split into thinner layers or sections, thus producing two layers or double the original surface area of the hide. For some purposes similar to those mentioned, thick, heavy hides may be split twice or even three times. The layers are known as "splits".

The true grain layer or split is the most value since, possessing its natural grain, it is the most durable. In the finishing processes the other splits may have an artificial grain stamped or impressed on one side. This impression may represent the grain formation of any animal skin, from crocodile to pig.

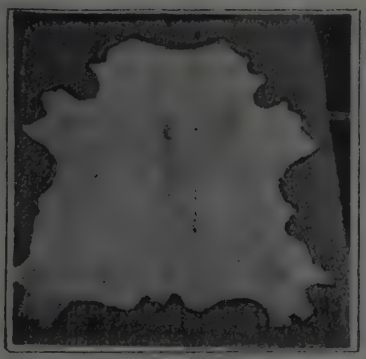

Fig. 1—Fresh hide from native market. Good pattern and trim

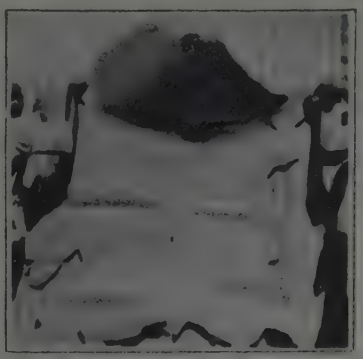

Fig. 2—Tanned hide showing poor pattern due to following incorrect ripping lines when flaying

Fig. 3—Disintegration of corium in tanned side (sun-dried) due to putrefaction. Flesh side of hide

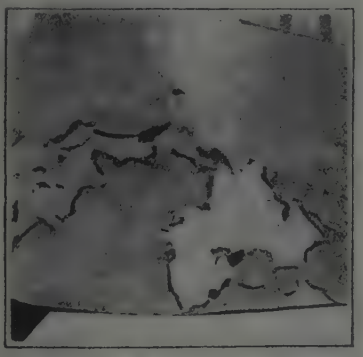

Fig. 4—Blister on grain side of tanned butt (sun-dried) due to putrefaction and hair-slip

Fig. 5—Showing correct ripping lines, fore-quarters. Note line for cross cut at knee joint

Fig. 6—Showing correct ripping lines, hind-quarters and belly

Fig. 7—Method of holding hide and flaying flank and chest with siding knife

Fig. 8—Flaying demonstration at native market. Knocking down the hide from thigh and flank with smooth club

Fig. 9—Method of using siding knife in fleshing

Fig. 10—Stretching hide for drying. Note that thin superficial muscles of back have been left on hide

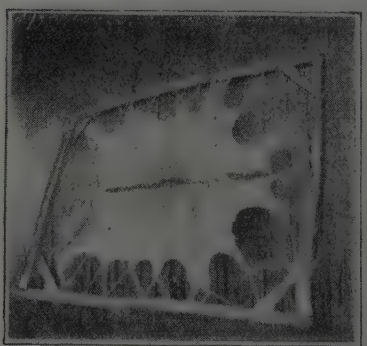

Fig. 11—Goatskin stretched in rough frame and placed beneath eaves of hut to dry

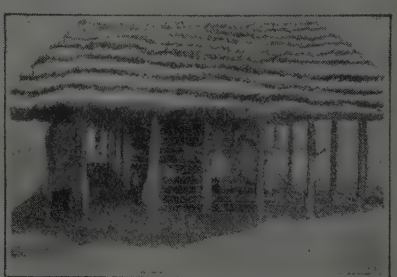

Fig. 12—Hide banda built from jungle materials

Faults and Defects in Kenya Hides.

The defects noted under this heading are often present to a large extent in hides exported from this country.

Poor Pattern and Trim, and Poor Flay.—These defects may be due to lack of skill on the part of the person flaying the animal, to lack of interest and carelessness, or to the use of unsuitable tools such as blunt knives, knives of wrong shape or having sharp points, or those of native make improvised from nails and hoop-iron. Poor pattern and trim are usually the result of ignorance regarding the correct lines to follow in the original ripping down of the hide in commencing flay. Many hides show cuts and scores on the bellies, flanks and tail area, whilst some are holed by careless slaughtermen.

Decomposition.—This fault may be due to a variety of circumstances, such as only partly drying the hide in the sun because of haste to market. It may be due to rolling the hide up and leaving it in the sun or in a hut, or, in the case of fallen stock, to belated flaying. In a few instances it may be due to weather conditions. It may occur in shade-dried hides, in instances when the hides are bundled before the neck ends are properly dried out.

This defect is all the more serious since decomposition is not always apparent before entering the liquor tanks at tanneries. During the process of tanning the decomposed hide may fall to pieces and become a total loss to the tanner (Figs. 3 and 4), or at best may be fit only for glue manufacture. Partial taint may be caused in hide *bandas* when the extremities are insufficiently strung for stretching, in which instances the edges of the leg pieces and neck ends may have curled, thus delaying prompt drying. Some hides show what is termed "hair slip"; that is to say, a loosening of the hair follicles, which results in the hair coming away from the hide in patches. When present in a small degree only, or tainted superficially, the grain is spoilt, but when putrefaction is deep-seated in the corium the damage may be found to be much more extensive, and this condition is known as "blister".

Brands.—These constitute a serious defect in Kenya hides, especially in those from cattle owned by the pastoral tribes. In instances where the brand has been lightly used, the damage done may affect the grain only, thus spoiling the appearance of the leather, but when the hot iron has been used heavily the burn may penetrate completely to the flesh side, causing a weakening of the whole structure of the corium, and possibly local cracks which will show up in the finished leather.

When leather is defaced by brands, it is quite unsuitable for upholstery, boot and shoe uppers, or for manufacturing purposes where the leather will be subjected to severe tensile strains, and where a smooth, unimpaired surface is required. When damage is not serious, the hide may perhaps be tanned as inferior sole leather, but when the brand is deep the affected portion may be wasted, causing the remainder to lose its cutting value.

Every effort should therefore be made to dissuade Africans from this practice, which causes immeasurable harm to our reputation in the hides trade, and which entails a loss of thousands of shillings daily to African stockowners. Branding of their cattle by Africans follows inbred custom and tradition, and much will have to be done in the form of propaganda and demonstration to persuade them to discard entirely this uneconomic form of identifying and adorning their stock; but it is felt that if they could be made to realize the extent to which they are penalized by the de-grading of their hides,

some movement in this direction would follow. Some alternative must be offered, and it is suggested that, instead of branding the bodies of the animals, the heads and shanks only should be allowed as sites for brands. On the hind legs, the brands should not be placed higher than the stifle joint, and on the fore-legs should be sited below the elbow.

Wounds, Scars, and Skin Injuries.—Wounds and scars may be due to an accident to the animal during life, whereby local injuries to the skin may have been caused, followed by thickenings in the process of healing. Ticks, tick-birds and thorns are other factors which often cause abscesses to form, with consequent damage to the hide. All of these are to a great extent unavoidable, as also is horning in the case of bull hides, but quite an appreciable amount of injuries to the grain can be avoided if a little extra care be taken at the time of slaughter.

Local hides from casualty stock are often damaged as a result of the carcass having been dragged out of the *boma* in which it died over rough, stony ground and possibly small hidden tree-stumps and thorns. These injuries are usually superficial, but the hide will be unsuitable for first-class work as leather. Such blemishes may sometimes escape notice here in Kenya, but after tanning they become apparent, thus lowering the value of the leather.

Dirty Hides.—This is another local defect which is avoidable. Dirty hides come mostly from the native reserves, or are casualty hides from farms, and are the result of carelessness at the time of flaying. They may have been trampled on during flay, or used as receptacles for the viscera of the animal when the carcass was cut up. It has been a common practice in the past for Africans to utilize the hide as a cutting-up table for the entrails. Such misused hides are very difficult to clean, owing to the presence of blood, manure and mud on the flesh side. The latter are conducive to the setting up of putrefaction, apart from the fact that their presence on the hide entails expensive cleaning operations at the tanneries. Occasional cases have been noted where the flesh side of a hide has been plastered deliberately with mud and manure with the object of concealing cuts and other blemishes. This practice is an offence under the Hides and Skins Rules, 1931, and is punishable.

Defects Caused after Drying.—Among these may be mentioned damage by rats and insects. The former can be avoided only by storing the hides in a ratproof shelter. Insect damage may be guarded against by sprinkling powdered naphthaline between the folded hides and skins.

Casualty or Fallen Hides.—A combination of defects is often present in hides of this class which, owing to periodical outbreaks of rinderpest and mortality from East Coast fever, at times form a rather large percentage of the total exported.

Take-off is particularly bad in fallen hides, mostly due to delayed flaying. When the carcass has lost its animal heat the hide is more difficult to remove, and cuts and scores result. Owing to stiffening of the limbs and muscles, pattern and trim may also suffer when ripping. Taint and decay may set in if the carcass has been left all night on the damp ground, and skin injuries are prevalent as a rule in this class owing to the carcasses having been dragged out of a *boma* or hut.

A fallen hide, if removed promptly from the animal, though not likely to be graded as No. 1, is nevertheless a valuable product, and if care be taken in flaying and preparation the owner will find that he will be repaid for his attention.

How to Flay an Ox.

In the absence of suitable equipment, it is practically impossible to follow abattoir methods of flaying, and the method suggested here is modified to suit conditions obtaining in native reserves and on farms where facilities for the purpose are non-existent.

It has been found by experience that, providing care is taken, it is by no means a difficult task to produce, without elaborate equipment, a clean, well-flayed hide of good pattern.

Flay cannot be carried out efficiently, however, if the slaughtermen use *pangas*, swords, daggers, or flattened nails as cutting tools to part the hide from the carcass.

With the aid of one straight-bladed skinning knife, and one curved knife (known as a siding knife), a length of half-inch rope, and a pole 5 ft. long and 2½ in. in diameter, an ox may be flayed in such a manner that the hide may compare favourably with an abattoir product. First of all the knives should be sharpened to a razor-like edge, and as a test it should be possible to shave the hair from the forearm. It is a great mistake to use a blunt knife, since extra pressure is needed in the cutting sweep, with consequent loss of control in depth of cut and direction.

Slaughter should take place under a fairly large tree, or stout poles with a crossbar affixed at the top should be erected, and the tree or gallows utilized as a hoist for the carcass during the course of flay.

After killing the animal and cutting the throat, have it *carried* under the stoutest branch of the tree, or to within two feet of the improvised hoist. Rest the animal on its back, with the hindquarters nearest to the tree or hoist. A man should hold a foreleg and a hind leg to prevent the carcass from falling to one side.

The initial cut should be made lengthways along the centre of the brisket, the point of the skinning knife is then inserted in the slit, which is then continued forward down the centre of the dewlap towards the head, finishing at the throat incision. The right foreleg is then held out straight, hoof in direction of the head, and a small cut is made crosswise as though to sever at the knee joint. The knife is inserted and the hide ripped down the inside of the leg, finishing into the initial rip just below the butt of the brisket. (*See* Fig. 5 for correct ripping lines.) The foreleg may now be skinned on each side, the knee joint cut through to disconnect the foot, and the point of the shoulder and side of neck are skinned. The left foreleg should be treated in the same manner.

Now rip the hide down the centre of the belly, continuing the first brisket cut back through the scrotum to the anus. A small cut is then made crosswise on the back of the hock joint of the right hind leg, the knife inserted and the hide ripped down the back of the leg finishing into the centre cut about six inches above the anus. (Fig. 6.) Flay the leg on either side as far as possible with convenience. The hock should then be jointed and severed. Repeat the operation on the left leg. Now flay the hide from each side of the carcass. The siding knife should be used in flaying the chest wall and flanks. (Fig. 7.) Endeavour to make long, even cutting strokes, and avoid working in pockets with the knife. When both sides are completed, the portions remaining unflayed are the back and shoulders, upper thigh region and tail.

In order to avoid spilling of the stomach contents at a later stage, it is advisable to open up the centre of the throat and neck, trimming the weasand or food duct and severing, after which it may be

knotted or tied with string. Open up the belly of the carcass by slitting from the brisket down the centre of the belly through the centre line of the cartilage of the aitch-bone, and loosen the rectum gut with knife.

It is not customary in this country to flay the head; this may be severed, cutting the hide just behind and as close as possible to the ears.

Now cut a slit between the shin bone of the hind leg and the sinew which joins the heel, and insert one end of the 5 ft. pole in the aperture. Slit the other leg in the same manner, and insert other end of pole.

Tie a rope round the centre of the pole, pass the end of the rope over the branch of the tree or crossbar of the hoist, and raise the carcass until the leg pole is about five feet from the ground. The intestines may now be removed. When doing so, reach through the abdominal cavity and pull the food duct through the diaphragm and remove, still attached to the first stomach.

Place some clean grass on the ground surrounding the carcass to prevent the hide from becoming soiled as flay progresses and the hide falls.

If one man now holds the hind leg piece at almost a right angle to the hanging carcass, another may ease or knock down the hide from the thigh and flank with a smooth club, occasionally aiding the parting of hide and carcass with his knife. (Fig. 8.) Treat the other hind leg similarly. Cut down the underside of the tail and skin carefully the root on both sides until the hand can be inserted in the opening thus made. Sever the tail at the root, hold the tail in both hands and pull, when the hide covering the tail will peel off to the tip, where the tail may now be parted from the hide. Skin down the back about a foot, then hoist the carcass until the neck end is clear of the ground. Continue flaying down the back to the neck, at the same time keeping an eye on the hide as it falls on the clean grass, making sure that it does not come into contact with any blood or filth. Flaying has now been completed, and the hide should be folded flesh side to flesh side, and taken at once to the hide *banda*.

Never use the hide as a dumping place for the internal organs of the animal, as blood and stomach contents are most difficult to remove from the flesh side. The secret of good flay is to use knives of suitable pattern, razor sharp, in the correct manner. Some cattle are easier to flay than others, and an ox which has been rested before slaughter is easier to flay than one which has been chased or driven a long distance.

Note.—Hides should not be removed from animals which have died from anthrax, as not only is the flayer in danger of contracting a fatal disease, but infection may be passed on to other cattle by the blood and liquid spilt on the ground when opening up the carcass. The hide is also a potential source of infection for any person who may handle it previous to tanning.

Flaying Sheep and Goats.

It is not considered necessary to go into details in connexion with the flaying of sheep and goats. Practically the same method as outlined for oxen may be used, with the exception that the knife is used to a lesser extent. The knife should be used for ripping, skinning the breast, flanks and legs, but from time to time the skin should be eased with the fingers and thumb and knocked off with the fist. Hoist the carcass in one movement only. When the tail has been skinned, the skin may be peeled off the back and neck by traction backwards and downwards. Do

not allow the skin to be used as a receptacle for carrying the intestines and meat.

THE CURING OF HIDES AND SKINS.

The curing of hides and skins in this instance means the methods used to preserve the raw products for storage and export. In countries of temperate climate, where tanneries operate and transport facilities are good, hides and skins, after flaying, are sprinkled with salt, folded, and despatched immediately to fellmongers or tanneries. In some countries they are thoroughly salted and packed into barrels for export, but where salt is expensive and scarce, and transport costs are heavy, they are air-dried. This method has been found the best for use in Kenya.

There are two methods of air-drying, one of which is to expose the hide to the direct rays of the sun, and the other is to dry the hide stretched on a frame in a shed or *banda*. Sun-drying has been found unsatisfactory for several reasons. Exposure to the rays of the sun causes the fine fibres of the grain to shrink and separate, making the hide or skin less waterproof and unsuitable for leather finishing processes. The heat of the sun may cause the particles of fat on the flesh side to melt and become absorbed into the corium, thus producing areas into which the tanning liquors cannot penetrate. Under present conditions, shade-drying is the best method for use in this country, and special premiums are paid by the hide buying companies for shade-dried hides. A good shade-dried hide may realize two to four shillings more than a sun-dried hide of similar type on the local market. The difference in time taken to prepare hides by either of the two methods is negligible, therefore it is obvious that the shade-drying method is definitely advantageous to the producer.

After flaying, the hide should be taken at once to the nearest drying shed, where it should be unfolded and placed flesh side upwards on the cleaning table.

It should now be fleshed or trimmed clean of fat, muscle and sinew with the aid of a siding knife. This type of knife, by reason of its thrown-back blade, presents a gently curved cutting edge to the surface of the flesh side of the hide, and has been found by experience to be less liable to gouge into the corium than knives of other types. It must be applied to the surface of the hide at the correct angle; if applied too steeply, damage to the hide may result.

In giving instruction in its use, the pupil should be told to lay the knife flat on the hide. Then, gripping the handle firmly (Fig. 9), he must attempt to make cutting sweeps to his left front. The handle should be almost in contact with the surface of the hide, and the blade nearly flat. The back of the blade should not be elevated more than a quarter of an inch at any point during the cutting sweep. If the knife is held correctly, it will be found that about one and a half to two inches of the blade function as a cutting edge. This method is found most successful in removing the thin superficial muscles in the regions of the back, flanks and ribs which are usually left on the hide by most African slaughtermen.

If the operator is cutting into the corium even in the least extent, the undersides of the strips of muscle after removal will show a white film, and if this occurs it is recommended that the thinnest of the back muscles be left on the hide. It should be remember that it is definitely preferable that small pieces should be left on the hide than to cut or gouge small particles of hide substance in the process of fleshing. In the course of drying the thin superficial muscles of the back become almost invisible, but they contract

quicker than the true hide substance and thus cause a corrugated appearance locally. At inspections of hide *bandas*, care should be taken to avoid mistaking the grooves caused by the contraction of these muscles for actual gouging into the corium, otherwise the hide-dresser in charge may be misled. Actual gouging usually shows up in a dried hide as a shallow depression having a defined ridge on one side only.

If care has been taken in flay, the hide should be perfectly clean, but if it has come into contact with blood or filth, water and a scrubbing brush may be needed to remove the dirt. If the hair side is dirty, this also should be washed.

Small holes may now be cut as near to the edge as possible of the extreme ends of the legs, belly and neck pieces. These holes should be sufficiently large to allow the insertion of a pencil, but not larger.

The hide may now be stretched lightly on the frame, with the flesh side uppermost. If the hide is from a humped beast, a small bundle of dry grass should be inserted from below into the hump cavity, since this assists even drying of that portion.

Pass native fibre or string through the holes, lightly stretch the leg pieces and tie to the parallel rails on either side of the frame. The belly and neck portions should then be treated likewise. Any other part of the hide that hangs loosely or sags, or that may show a tendency to curl, should be pierced at the edge and tied to the rails or uprights of the frame. (Fig. 10.) Avoid overstretching the hide, or it will lose its original shape. The hide is now stretched like a tent, and any surplus water still remaining on the flesh side may be lightly scraped off with the knife. This precaution will assist rapid drying of the hide. The length of time necessary to dry the hide thoroughly will depend on weather conditions, but it usually extends from three to five days. The hide should not be removed from the frame until it is absolutely dry. This is most important for two reasons: The hide-buyer finds it an uneconomical proposition to buy hides of high moisture content, since they lose a higher percentage of weight than others in transit to overseas ports. The other reason is that the only partly dried hide, if baled with other dry hides, may decompose and set up decay in those with which it is in contact. It has been found that the belly and middle usually dry first on the frame, followed by the leg pieces and tail end of the butt. The neck and shoulders, being thickest, particularly in bull hides, are usually the last portions to dry. A daily inspection should be made by the hide-dresser. He must watch for the appearance of folds in the drying hide where decay may possible commence, and for curling of the edges of the leg pieces, and when this occurs he should re-stretch the portion to prevent "blowing" by flies.

Hides may also be dried perfectly on square upright frames, and where timber is plentiful for the extra space required, the upright frame method is recommended. The choice of either method should depend on local conditions and facilities for building and efficient preparation.

Sheep and Goat Skins.

Skins are easy to cure, due to their convenient size, and after trimming on the table should be lightly stretched on a frame constructed from four sticks and some string. (Fig. 11.) A properly flayed skin should need little or no fleshing and cleaning, and it is considered that efficient flaying should be the first aim in improvement work. As in the case of hides, it is far better to leave small tissues than to ruin a skin in attempting to remove them.

The skin may be pierced for stretching in the same manner described for the hide, the holes being just large enough to allow threading of the string or fibre.

The frame containing the stretched skin may then be placed upright under the eaves of a hut, inside a *banda* or empty hut, or hung under a shady tree. If placed under a tree, the frame should be moved under cover during a shower of rain.

The Grading and Marketing of Hides and Skins.

Few hard and fast rules can be laid down to be followed without deviation in the grading, selection, or classifying of hides and skins. Those rules which are recognized by buyers as to the number of cuts and scores permitted in certain grades of hides are flexible and indefinite, and may depend to an extent on market demands and requirements. Grading in Europe is carried out by experts with years of experience. In carrying out their duties they must pass personal judgment on each hide or skin, carefully noting the various defects such as take-off, pattern, and the more obvious faults visually, at the same time using the hands for the detection of eruptions and blemishes under the hair on the grain side. Keen sense of smell, sight and touch are necessary qualifications. In this country the selecter employed by a hide-buying firm is usually an Arab of considerable experience in the hide and skin trade.

Pattern, size and weight may be deciding factors in arriving at a decision, or a combination of small defects may affect the issue.

The system of grading is of economic value both to the buyer and to the producer, and it is the only fair and satisfactory method of buying. Its use ensures a fair price to the producer of sound hides, while the careless, disinterested producer gets a price commensurate with his effort and product. The practice of most Arab and African itinerant hide traders who travel in the native reserves is to buy hides *shella bella,* or unclassified, and this does not tend to improve the standard of local hides. African producers should therefore be given every encouragement and assistance to sell their hides and skins to those buyers who purchase by selection, or according to quality. At the same time it should be pointed out to Africans that the seller must take up a reasonable attitude with regard to de-grading for obvious defects.

The qualities of a first-grade hide have been explained already. In Kenya, three grades are usually recognized in the shade-dried class. Generally speaking, a brand on the butt, even a tiny one, will place an otherwise perfect hide in Grade 2, as also will a perforation over six inches in from the edge, one sore or abscess, or scratches on the grain side. A Grade 3 hide may show localized hair slip, and any or all of the above-mentioned defects to a certain degree. Many hides come into Grade 3 because of a brand running across the butt, although in other respects they are good specimens. Hides possessing defects too serious for grading may be classed as "rejects" or "glues". A local factor in grading that is not always appreciated by Africans is demodectic mange. This disease is present in animals in some native areas, and causes serious damage. It may not be apparent in the hide before drying, but after drying small white spots are discernible on the flesh side, in most cases on the forelegs and shoulders.

A hide from an old cow is less valuable than that of an ox. Generally, hides from casualty or fallen stock are still less valuable. These points should be remembered

when spreading propaganda to Africans in connexion with improvement. Many of them may not have heard of grading in the past, and demonstrations by means of specimen hides obtained from local buyers may assist materially in making clear to them why they may be penalized for defects under the grading system.

Suggestions for Hides and Skins Improvement.

A scheme for promoting improvement in preparation of hides and skins need not necessarily be an expensive undertaking amongst the agricultural tribes of Kenya, and in some areas considerable success has been obtained by inducing the local inhabitants to take up hide dressing as a trade or business undertaking, in contradistinction to employing them as paid hide dressers on wages drawn on a central authority such as a Local Native Council.

It has been found that over a hundred natives may be provided with employment in a native reserve as dress or hide traders and dressers, each working for a small fee for each hide prepared. The fee, 25 cents, payable by the owner of the hide is small, but monthly totals earned in this way compare favourably with wages earned on farms and in industrial works.

In undertaking hides improvement work in such districts as the Masai Reserve, the Northern Frontier District and Turkana, the inhabitants of which are mainly pastoral nomads by habit averse to change, numerous difficulties and setbacks would doubtless be encountered when applying a scheme on similar lines to that outlined above. In other districts local conditions might stress a need for some modification in detail and application. It is hoped that a brief outline of a suggested method may serve a useful purpose in connection with proposed improvement work in new areas.

The work may be commenced by building a hide *banda* at a station or centre. Equipment should consist of a table 5 ft. by 3 ft., old petrol drums for water, a number of flaying and siding knives, and a couple of scrubbing brushes. A slaughter hoist or poles should be erected for flaying demonstrations. Natives should be engaged for training as instructors and *banda*-builders for future work in the district. The number engaged should depend on the number of *bandas* it is proposed to erect and supervise. If one native be engaged for every twelve *bandas*, efficient supervision and demonstrations at markets should be ensured. At the same time, local chiefs should be requested to send in one or two natives each for training as hide dressers. These pupils will take over hide *bandas* to run for their own profit later on. Arrangements should be made to receive a daily supply of fresh hides for use at the training *banda*. One week's intensive training, with lectures and demonstrations, should suffice to obtain reasonable proficiency in the case of the dressers. On completion of training, they may be sent back to their locations with instructions to collect poles, grass and fibre, with the assistance of the chief, for the construction of *bandas*.

The pupil-instructors should receive about three weeks' training, including elementary instruction in the building of *bandas* from jungle materials.

Talks on the subject in hand may now be given to chiefs and members of Local Native Councils with permission of the District Commissioner at his *barazas*, and to chiefs and elders at weekly meetings in their respective locations. The potential economic gain to individuals who follow instructions by having their hides

shade-dried should be stressed, and promises of assistance in the event of marketing difficulties occurring should be given. After these talks, they should be allowed to ask questions, since when these are followed up much useful information may be gathered regarding local marketing, cause for petty fears may be removed, and a definite promise of personal assistance will usually secure confidence and some enthusiasm.

Hide *bandas* should be sited at native markets, at trading centres, or on market routes. As soon as the materials have been collected at the sites for the *bandas*, the construction of these may be commenced by the trained instructors, with assistance from the chief, headmen and local inhabitants. It has been found possible by obtaining general interest in the scheme to complete on an average five *bandas* per month over a period of a year, where local conditions were favourable, with a staff of six instructors.

Slaughter hoists should be erected at all markets and places where native butcher shops are located, and demonstrations in improved flaying should be carried out wherever possible. When the first *banda* has been completed, it may be handed over to one of the trained dressers to manage. An instructor should be left with him for a day or two to ensure proficiency.

If the dresser wishes to buy hides in addition to preparing them, he may be sent to the warehouse of the nearest hide-buying firm to spend a day or two with the firm's selector, where he will be able to learn a few rudimentary rules of grading. The hide-buying firms are usually pleased to consent to this procedure, and are always willing to assist native enterprise in the hide trade.

Faults and defects may be located very quickly if numbered gummed labels be issued free to all occupiers of *bandas*. The *bandas* should be numbered, and labels bearing a corresponding number should be affixed to all hides on the flesh side before being taken off the frames for sale. All hide-buying firms should be advised requested to forward complaints, quoting the label number. By this means it will be found possible to correct faults in many instances on the day after receipt of a complaint. The cost of the labels is quite small. Fewer inspections will be needed to maintain efficiency, and hides can be identified at any point *en route* from the *bandas* to the buyers' stores by inspectors. It is advisable to have a set of rubber stamps (numerals) at hand where labels are issued, in order that when a certain number is exhausted a fresh supply may be issued without delay. A supply of unnumbered labels should always be kept on hand for this purpose. A convenient size for labels is 2 in. by 2½ in., and they may be printed as follows: "Hide Banda No.", with a blank space below for the numeral, and below again the name of the district.

It is most important that all hide dressers and native butchers be in possession of flaying and siding knives, and it is recommended that Local Native Councils be urged to provide funds for the supply of knives to all Africans interested at cost price or at an assisted rate.

Notes.

Hide *bandas* should be built whenever possible on an exposed site near water.

The hide dresser should live on the site or quite near to his *banda*.

At *bandas* where the output is small, it has been found advantageous to put in as dresser the local native butcher, or a native who already has some part-time employment.

When a higher rate is charged by hide dressers for preparing dirty or smelly hides, more care is taken thereafter by suppliers, and hides are brought in fresh.

When building *bandas*, care should be taken to allow sufficient space to admit the wind. The height of the eaves should not be less than five feet.

In order to avoid heating down the centre line of the hide, the top rails of tentwise drying frames should be not more than 2 in. in diameter. Experience has shown that it is possible to avoid any suspicion of taint if this precaution is observed.

Before laying out *bandas* it has been found advisable to ascertain the direction of the prevailing wind, since drying is accelerated when the wind strikes the side of the *bandas* at about 45 degrees.

A *banda* 36 ft. long by 13 ft. wide will house 17 tentwise drying frames, and leave sufficient space for a table and for the dresser to work. (Fig. 12.)

Barbed wire should be affixed by means of 3/4 in. staples at intervals of 4 to 5 inches between strands to the outside of wall posts to protect the hides from hyenas and other animals.

Banda = Shed (Fig. 12). *Panga* = Cutlass.

East Africa and the Tsetse Fly

A Review

By T. W. KIRKPATRICK, M.A., *Dip. Agric., F.R.E.S., Entomologist, East African Agricultural Research Station, Amani, Tanganyika Territory.*

Tropical Africa covers an area of some four and a half million square miles. Nearly two-thirds of this is infested by one or more of the twenty-one species of the genus *Glossina*—dull, insignificant-looking flies known as tsetses. Perhaps the word is a corruption of the Swahili *inzi*.

The majority of Europeans in East Africa live in "fly"-free districts, and probably do not realize the immense importance of the tsetse. It has in the past affected, and still continues to affect, the progress of civilization more than any single group of insects, except the malaria-carrying mosquitoes. The proportion of East Africa infected is nearly as great as that of Tropical Africa as a whole. Eight species of tsetse occur in Tanganyika, six in Kenya, and six in Uganda. From Northern Rhodesia and Nyasaland only three species are recorded, but these are found over wide areas of those territories.

As is well known, the economic importance of tsetse flies is due to their ability to carry the trypanosome protozoa, which causes the diseases of sleeping sickness in man and *nagana* in cattle. There are two types of sleeping sickness—the "Rhodesian" disease carried mainly by *Glossina morsitans* and *G. swynnertoni*, and the "Gambian", carried by *G. palpalis*. *Nagana* of animals is transmitted by the two former of these, and also by *G. pallidipes*, *G. austeni*, and *G. brevipalpis*. Other species may also carry trypanosomes, but they are probably of minor importance.

There has recently appeared an authoritative and comprehensive account[1] of the present state of our knowledge of the tsetse problem in East Africa.

Animal trypanosomiasis has been by no means an unmixed curse. Soil erosion, even though it has only recently become "news", has been, is, and will continue to be, one of the greatest problems of Tropical Africa. Nothing that has so far been done to combat the menace of soil erosion has been so effective as the work of the tsetse flies.

In the fly belts, man lives in scattered villages. He cultivates (if he is not too debilitated by sleeping sickness) after burning the grass, and this helps to retain the tsetse. He cannot keep cattle, but there is an abundance of game, which he can hunt.

So far, not so good, but at least not too bad. But, outside the fly belts in the first place, the African native developed the Goat Standard. Goats and cattle are the sign of wealth. Grass-burning, originally done in order to cultivate, has provided extensive grazing areas. It has also, by reducing the vegetational cover, enabled the tsetse, or at least several species of them, to extend its area. The native therefore, having created country in which he can become rich, must, if he wishes to retain his wealth, retreat from this country before the advance of the tsetse.

1 "The Tsetse Flies of East Africa: A First Study of their Ecology, with a View to their Control," by C. F. M. Swynnerton, Director, Tsetse Research Department, Tanganyika Territory.—*Trans. R. Ent. Soc. London*, Vol. 84, 1936, xxxvi + 579 pp., 22 plates, 7 maps; £5 10s., od.

The result is the closer settlement of the pastoral agriculturist; trees are cut down, grass is burnt, the land—cultivated during the rainy season—is exposed to erosion by wind and rain. Cattle increase to such numbers that they are only kept down by starvation—dying because they have destroyed their own grazing. The native is probably better off materially; he certainly has more "wealth" in the form of miserable, half-starved cattle, and he is more accessible to administrative and medical services. But he is rapidly destroying the Africa which has taken millions of years to evolve. Abolish the tsetse, and the area open to destruction is increased.

Shall we then acclaim the tsetse as the guardian of the country—for this it undoubtedly has been—and stigmatize the Tsetse Research Department, not only as the squanderers of a trivial amount of the country's money, but as the potential destroyers of the inherited agricultural wealth of much of East Africa? No. The scattered agriculturist, decimated by sleeping sickness and unable to keep cattle, is out of date. Modern humanitarianism, apart from (or because of?) the needs of commerce, demands the improvement of his lot.

To retreat before the tsetse and allow the pastoralist to destroy the remaining fly-free country with overstocking and erosion, is clearly a suicidal policy of *laisser-faire*. To reclaim land from the tsetse, yet still to allow the native to destroy even larger tracts of his country, is surely the eighth deadly sin—doing good that evil may come.

What then is the ideal at which we should aim? To drive out the tsetse, but, at the same time, to plan the settlement of the reclaimed country. Indigenous trees must be preserved; the quality of the native cattle must be improved, and, of far more importance, the density of its population strictly regulated, so that erosion of the soil is prevented and the grazing improved instead of ruined; rotation of crops and the use of manures must be taught; a greater variety of both food crops and cash crops introduced.

We have the knowledge necessary to do this, and no one will deny that we have the moral obligation to do it, for the sake of the native and of the fuller development of Africa. But we have not the right to destroy the tsetse unless we plan in advance the settlement of the reclaimed land. For the tsetse has been the guardian of Tropical Africa; but, since we have assumed the role of guardian of the native, the tsetse must now yield place to us.

How this is to be—and to some extent has been—accomplished, Mr. C. F. M. Swynnerton describes in his closely written volume of some 600 pages. Few people will read the whole book (the reviewer himself has not), but there is nobody in any way concerned with the native policy, agriculture or development of East Africa who will not find parts of it of absorbing interest.

To anyone who, like the reviewer, is particularly interested in ecology, the main attraction of this account of the work of the Tsetse Research Department is the fact that it is almost the only major entomological—or, indeed, any other—problem that has been tackled principally from the viewpoint of practical ecology. There is nothing about insecticides, and little about any other form of direct attack. The volume is mainly devoted to a scientific study of the natural history of the different species, and an account of the possibilities of indirect attack on them by modification of their environment and through their food supply.

"The two main savanna communities of Tanganyika are the dry thorn-bush or

nyika (*Acacia-Commiphora*) and the taller, more uniform *miombo* woodland (*Isoberlina-Brachystegia*). The *nyika* mainly occupies the northern part of the Territory, entering from the Sudan and Somaliland through Kenya; the *miombo* comes in from the south, and dwindles out at the northern border, both on the east and west."

" *G. morsitans* characterizes the *miombo*, but also inhabits types of thorn-bush in Bukoba and southern Uganda, under a higher rainfall. *G. pallidipes* overlaps much of this *morsitans* country. The tsetse of the *nyika* is *G. swynnertoni*; its range is widely overlapped also by that of *G. pallidipes*. *G. longipennis* lives in the drier parts of this thorn-bush. *G. swynnertoni* occurs across much of the northern third of Tanganyika, and is invading Kenya. The two flies last named infest most of the eastern lower-lying portion of Kenya."

" *G. brevipalpis, fuscipleuris* and *austeni* are tsetses which are based on dense wooding—often associated with high rainfall, but sometimes with subsoil moisture. *G. austeni* occurs through the coastal belt of East Africa, back to the edge of the central plateau. *G. brevipalpis* is found in the same area, but re-occurs also in the region of the lakes. *G. fuscipleuris* is found near the southern Kenya border and in localities in Uganda. *G. palpalis* is mainly a water-side tsetse. It is almost entirely confined in Tanganyika Territory to the shores of the Lakes Victoria and Tanganyika. In Uganda and Kenya it extends far along the main rivers that flow into or out of the lakes."

" The most important general point is that each species seems to need a concurrence of different vegetational types. Thus, within a general fly belt of any one species, the tsetses occur in numbers only about the meeting points of two or more vegetational types. Each of these types is necessary to supply a different requirement of the flies; for example, the conditions necessary for mating, breeding, feeding, or sheltering, from lethal degrees of heat or desiccation, or from enemies, during rest."

" If therefore any essential type is rendered unsuitable by destruction or mere modification, the tsetse, it would seem, must go."

There are many other problems that ought to be investigated in the same way, and this book is commended to those whose practical entomology is confined to "spray" or—still more drastically—"uproot and burn". But ecological studies require patient work over a long time and the expenditure of considerable money; for immediate results, spraying and uprooting are often necessary.

But with the problem of the tsetse, ecology is justifying itself; Beelzebub, the God of Flies, has ruled long enough; Mr. Swynnerton has proved himself to be a very capable Devil.

The following notes on the East African species of tsetses, based on the keys in Swynnerton's work, but with as many simplifications as possible, may be of interest to non-entomologists who would like to identify the species of this genus.

Tsetses are two-winged flies, of the same order (Diptera) as house flies, horse flies, and mosquitoes. They may be distinguished from all other flies as follows:

In the resting position (Fig. 1) the wings of a tsetse fly overlap each other like the blades of a closed pair of scissors, but they coincide completely and lie flat. They show no separate points. The wings are long and project well beyond the abdomen, which they hide. They therefore give the fly a very elongated appearance.

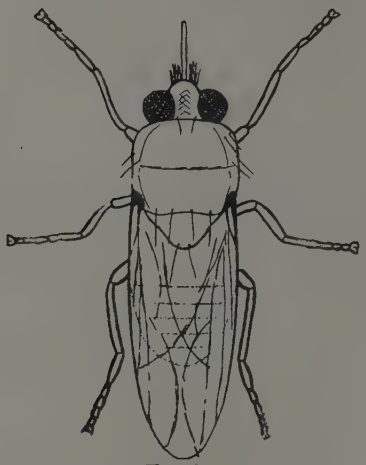

FIG. 1
Diagram of tsetse fly in the resting position.

In "clegs" and horse flies, which are sometimes mistaken for tsetses, the wings either meet above the abdomen but slope to each side like a roof, or, if they lie flat like those of tsetses, the tips of the wings do not coincide but are well separated.

The hatchet-like shape of the cell (or space between the veins) in the middle of the wing is peculiar to tsetses (Fig. 2a).

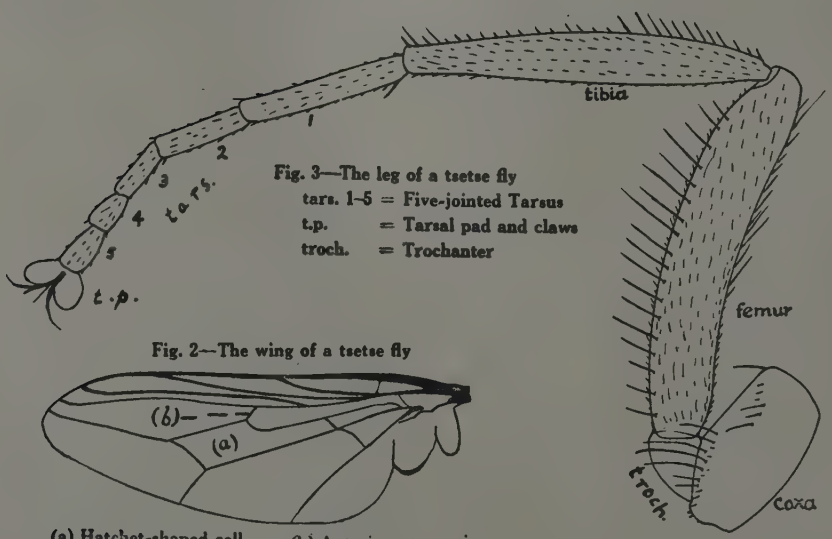

Fig. 3—The leg of a tsetse fly
tars. 1–5 = Five-jointed Tarsus
t.p. = Tarsal pad and claws
troch. = Trochanter

Fig. 2—The wing of a tsetse fly

(a) Hatchet-shaped cell (b) Anterior cross-vein

SIMPLIFIED KEY TO THE EAST AFRICAN SPECIES OF *GLOSSINA*.

A [(B) (C)] Large tsetses, wing length 11.0—13.5 mm. Colour brown or pale brown; tarsi of hind legs not entirely dark brown or black above; abdomen without sharply contrasted dark bands.

The *fusca* group ..... (1)

(1) Thorax with four distinct dark spots ..... *longipennis.*

Thorax without dark spots ..... (2)

(2) Anterior cross-vein (Fig. 2b) darkened, i.e. a dark spot on the wing: *brevipalpis.*

No dark spot on the wing ..... (3)

(3) Sides of thorax dark grey, coxæ (Fig. 3) of hind legs mouse-grey ... *fuscipleuris.*

Sides of thorax light pinkish-grey, coxæ of hind legs buff ..... *fusca.*

B [(A) (C)] Small tsetses, wing length 6.5—8.0 mm. Very dark in colour; tarsi of hind legs entirely dark brown above; abdomen without sharply contrasted dark bands. all blackish brown or dark grey. The *palpalis* group.

One East African species only ..... *palpalis.*

[If with other characters similar to above, but abdomen shining ochreous ..... *austeni.* (*See below.*)]

C [(A) (B)] Medium to small tsetses, wing length 7.0—10.0 mm.; tarsi of hind legs not entirely dark brown above (except in *austeni*), abdomen with conspicuous dark bands (except in *austeni*).

The *morsitans* group ..... (4)

(4) Tarsi of hind legs entirely dark brown, abdomen shining ochreous-tawny with traces of ill-defined dark bands: *austeni.*

Tarsi of hind legs not entirely dark brown, abdomen with conspicuous bands ..... (5)

(5) Last two joints of the tarsi of the front and middle legs without contrasted dark tips ..... *pallidipes.*

Last two joints of the tarsi of the front and middle legs with sharply contrasted dark tips ..... (6)

(6) Dark bands on abdomen narrower, and rounded on the apical side, thus ⌣ ⌣ ..... *morsitans.*

Dark bands on abdomen broader and oblong, thus ▭ ▭ ... *swynnertoni.*

Review

SOILS, THEIR ORIGIN, CONSTITUTION AND CLASSIFICATION: AN INTRODUCTION TO PEDOLOGY, by G. W. Robinson: Thos. Murby, London; Second Edition, 1936, 442 pp., 20/-.

The first edition of this book appeared only four years ago. In its present form it is longer by some 50 pages, and has the improvement of some good new illustrations. The text has been recast to accord with recent advances in the study of pedogenic processes, the clay complex, base exchange, soil moisture and soil classification, and also contains valuable additional examples and corroborative detail in many sections, as in the chapters on the soil groups and soil geography. The changes do not alter (though they add further distinction to) the characteristic quality of the book as a personal statement of the content of the subject of pedology treated in its philosophical aspect.

The relationship between soils and agriculture is thus not at all a preoccupation of the author until his last chapter is reached, when the directions in which the pure study has application are indicated in general terms. It is undoubtedly for this reason that the book has so direct an appeal to us who are working in a newly developing tropical region. Here in our problems of soil improvement and of adaptation of agricultural methods to factors of soil and climate that we cannot change, we can look for little immediate guidance from the tradition of applied agricultural chemistry that has been built up by a hundred years of largely empirical study of the behaviour of British crops on a few British soils. Professor Robinson's release of the treatment of the subject from dependence on examples of how mangolds respond to superphosphate on chalky boulder clay is thus in the highest degree welcome, and we can the better follow, and apply to our own case, his enlightening exposition of fundamental soil properties. This he claims neither to be complete nor impartial, but it is at any rate a fair, experienced and critical account of both *soil* as a physical, chemical and biological system and *soils* in their infinite variety as they have come to knowledge throughout the world.

A quotation at some length from his concluding chapter will illustrate Professor Robinson's convictions on the essentially practical share that his subject, as thus studied as a branch of pure science, can have in a programme of agricultural research. After outlining the problems that the pedologist is called upon to solve when he assumes the role of agricultural chemist, he says:—

"There appear to be two approaches to the solution of the problems of soil fertility and soil management. In one, knowledge is acquired by observing the effect on crop production of various methods of cultivation, management, cropping, and manuring. By isolating the variables and applying the latest statistical methods the results thus obtained can be given the highest significance. Yet the results of such experiments contribute little to increasing our knowledge of the master-problem of the contract between soil and plant.

"In the writer's judgment the other approach must rather be sought, namely, the study of this master-problem of plant nutrition and growth. The pursuit of fundamental knowledge needs no justification, for this is the classical road by which science has passed on its gifts to practical life.

"Field experiments must always be carried out, particularly in undeveloped countries face to face with new problems, but the writer would deplore any avoidable diversion of material resources and creative thought into

this pedestrian type of investigation, which opens out no new horizons, but merely answers the commonplace questions it is required to solve."

This is perhaps a little hard on the pedestrian, who will, however, no doubt continue to claim his rights as he has in other walks of life. But it declares a principle, which is from time to time lost sight of in the framing (and more often still in the execution) of programmes of crop and soil investigation, and of which it is well that we should be so outspokenly reminded.

It is a pity that a book well qualified by style and content to attract a wide circle of readers should be priced so that many will not in fact buy it (as they would wish) but will be compelled to borrow. Properly it is not a borrower's book—it should be dipped into often and at leisure.

G.M.

Correspondence

RATIONS FOR LIVE STOCK.

The Editor, The East African Agricultural Journal.

Sir,—Having read a recent article on Mixed Farming in East Africa, II, by Colin Maher, I consider that in the section on "The Management of Grassland" (*a*) he has come to some rather extraordinary conclusions with regard to the feeding requirements of the dairy cow.

Accepting *Rations for Live Stock* as the authority on which he bases his conclusions, one finds that his figures for the maintenance requirements of a 9 cwt. animal are those of a fattening animal and not a dairy cow. He quotes the requirements as being for a 9 cwt. animal, 22 lb. dry matter, 6 lb. starch equivalent, and 1½ lb. digestible protein. This amount of digestible protein is in fact the maintenance plus production requirements of a 9 cwt. fattening animal (p. 26, *Rations for Live Stock*).

The maintenance requirements of a 9 cwt. dairy cow are generally taken as being 6.0 lb. S.E. and 0.6 lb. P.E. (p. 32, *Rations for Live Stock*).

If one accepts his figures for the probable value of Kenya pastures, namely 12.0 lb. S.E. and 2.4 lb. P.E. per 100 lb. green material, and using the above maintenance requirements, one finds that 110 lb. of grass contains 13.2 lb. S.E. and 2.64 lb. P.E., leaving a surplus for production of 7.2 lb. S.E. and 2.04 lb. P.E. The starch equivalent would be enough for 2¾ gallons of milk and the protein equivalent enough for over 3 gallons.

Mr. Maher mentions the fact that the energy wasted in walking about under usual Kenya conditions would probably raise these maintenance figures, but in fact makes no allowance. The additional amount of S.E. required for grazing various types of grassland is generally taken to be as follows (p. 30, *Rations for Live Stock*):—

Good fattening pasture ...	1 lb. S.E.
Average	2 lb. S.E.
Poor	3 lb. S.E.

Considering the amount of time the average Kenya cow spends in walking about, to and from water, and to and from the homestead, I think one would not be far out in putting down the additional starch equivalent used up as being 2½ lb. In other words, on grazing such as that evaluated by Mr. Maher, the cow is unlikely in theory to get enough S.E. to produce more than 1¾ gallons and enough P.E. to produce more than 3 gallons.

This agrees with results in practice as quoted by Mr. Maher. Obviously the falling-off in condition is due to an over-rich protein diet.

The feeding of the dairy cow in Kenya during the dry weather, though of much greater importance, cannot be discussed in a short letter.

I remain,
Yours faithfully,
G. S. FORBES.

Malagot, Lumbwa,
24-11-36.

Reply by Mr. Maher.

I am grateful to Mr. Forbes for pointing out a slip on page 16 of my article on dairying and make my apologies for an error which must have arisen during a rush of work just before I went on leave. Actually, the 1936 edition of Morrison's *Feeds and Feeding* gives 0.65 lb. of digestible protein as the recommended amount for the maintenance of a good 1,000 lb. (9 cwt.) cow under usual conditions; thus, with the hypothetical composition of the grass which I gave there would be sufficient for the production of 3.2 gallons of milk, not just under 2 gallons as I stated.

In such a case, as Mr. Forbes points out, extra carbohydrates would be needed to balance the diet.

In practice the composition of grass in Kenya is likely to vary considerably during the year, and only by methods of trial and error and careful observation of the milk records and the condition of the animals can the correct adjustment of the diet be made.

In fact, Morrison gives the content of digestible protein of "Grasses, mixed, at haying stage," as 1.7% only. 110 lb. of grass of this type would give only 1.87 lb. of digestible protein or a surplus of protein sufficient for the production of just under 2 gallons of milk; it is possible that poor, parched Kenya pastures sometimes have an even lower feeding value.

It should be noted that Morrison gives 1.11 lb. to 1.27 lb. of digestible protein as the daily requirement of a growing dairy animal with a weight of 900 lb., and 1.16 to 1.33 lb. as the requirement of a growing animal weighing 1,000 lb.

I made no attempt to estimate the increase in the maintenance requirements of dairy cows on Kenya pastures, since this would have been merely guesswork, while the figure would vary considerably from district to district, and at different times of the year. Whatever is the actual loss in energy it is reflected on the milk record sheet and supplementary feeding must be adjusted accordingly.

Annotated Host List of Uganda Parasitic Fungi and Plant Diseases—Part I

By C. G. HANSFORD, *M.A., F.L.S., Mycologist, Department of Agriculture, Uganda.*

The last list of Uganda Fungi published was that of Miss Wakefield (Kew Bulletin, 1920, p. 289 *et seq.*), and since that publication the collection and identification of these organisms has proceeded steadily, though at times not very rapidly. The result is that the list referred to is now much out of date, and the following represents an effort to collect together all the records available. A large number of purely saprophytic fungi have been recorded and identified in Uganda, but most of these are omitted from the following list. Many new species are mentioned in it, and it is hoped that the Latin descriptions of these will be published shortly. In some groups there is doubt as to the accuracy of the older records, but no time has been available to revise these, as efforts have been concentrated on keeping abreast of the more recent collections; in any case, the material of the older collections is at Kew Herbarium, and no duplicates are available in Uganda.

In the list the host plants have been arranged in families, according to Hutchinson's system; hosts other than flowering plants are grouped together. The writer has combed all the literature and references he could find, and it is believed that the list is complete to date. He would be much obliged if his attention were drawn to any omissions from the list.

I have to thank Miss E. M. Wakefield, of Kew, for many of the identifications; others have been made by members of the staff of the Imperial Mycological Institute, Kew. Prof. Chipp has assisted with the determination of many species of *Cercospora*, and, until his death, Prof. F. L. Stevens had collaborated with me in the determination of the *Meliolineae*.

ALGAE.

CLOSTERIUM sp.
Myzocytium proliferum Schenk, in the vegetative cells.

OEDOGONIUM sp.
Olpidium entophytum Braun, in vegetative cells.

SPIROGYRA sp.
Rhizophidium globosum (Braun) Schröter,
Lagenidium rabenhorstii Zopf, and
Myzocytium proliferum Schenk, all in vegetative cells.

PLEUROCOCCUS sp.
Nectria haematites Syd.

FUNGI.

ASTERINA sp.
Chaetostigmella sidae Hansford.
Phaeostigme sp.
Phaeodimeriella asterinae Hansford.
Leptosporella asterinae Hansford.
Blastotrichum sp.
Titaea callispora Sacc.
Helminthosporium sp.

CLADOSPORIUM sp.
Cephalosporium sp.
Fusidium sp.

CORDYCEPS sp.
Sporotrichum isarioides Hansford.

ELSINOE sp.
Oospora sp.
Fusarium macroceras Rkg. & Wr.
Fusarium stilboides Wr.
Cladosporium sp.

EXOSPORIUM LATERITIUM.
Stigmina exosporii Hansford.
Cephalosporium sp.

HELMINTHOSPORIUM TRIUMFETTAE.
Verticillium epiphytum Hansford.
Sporotrichum triumfettae Hansford.

HYPOXYLON sp.
Ceratosphaeria lampadophora (B. & Br.) Niessl.
Nectria Rickii Rehm.
Nectria sp. indet.

KRETZSCHMARIA sp.
Sphinctrina cubensis B. & C.

MELIOLA sp.
Letendroea sp.
Perisporium paulliniae Stevens (prox.).
Dimerium sp.
Epistigme sp.
Phaeostigme japonicum Syd. (?).
Phaeostigme sp.
Paranectria flagellata Hansford.
Paranectria meliolicola Stev., var. *major* Hansford.
Paranectria ugandae Hansford.
Paranectria willdemanniana P. Henn.
Nectria sp. (no conidia on host or in culture).
Calonectria sp. (conidia *Atractium* sp.).
Calonectria sp. (conidia *Spicaria* sp.).
Cephalosporium sp. (with perithecial stage *Nectria* sp.).
Trichoconis sp. (?).
Helminthosporium guareicolum Stevens.
Helminthosporium guianensis Stevens.
Helminthosporium parathesicolum Stev.
Tetracoccosporium sp. (very like *Spegazzinia ornata* Sacc. as described and drawn by Van Overeem in *Bull. Jard. Bot. Buitenzorg*, III Ser., V, liv. 4, p. 286).
Fusarium sp.
Isaria meliolae Hansford.
Arthrosporium fici Hansford.
Arthrosporium parasiticum Wint.
Arthrosporium ugandense Hansford.
Naemosphaeria sp.

MUCOR sp.
Piptocephalis freseniana De B. & Woron., var. *macrospora* Hansford.

OIDIUM sp.
Cicinnobolus cesati De Bary.

PHRAGMOCAUMA VIVENTIS.
Dendrodochium phragmocaumae Hansford.

SPHAERIACEAE (various).
Nectria episphaeria (Tode) Fr.
Nectria episbhaeria (Tode) Fr., var. *coronata* Wr.

UREDINAE (Rust Fungi).
Eudarluca sp.
Darluca filum (Biv.) Cast.
Didymella sp.
Paranectria sp.
Verticillium sp.
Cephalosporium sp., very common on *Hemileia* on coffee, and penetrating into the tissues of the leaf, causing dark brown to almost black areas around the original rust spots.
Cladosporium hemileiae March, & Stey., probably only a form of *C. herbarum* Lk,. as such are quite common on other rusts.
Cercosporella sp.
Tuberculina persicina (Ditm.) Sacc.
Titaea sp.

USTILAGINEAE (Smut Fungi).
Fusarium heterosporium Nees.
Fusarium moniliforme Sheld.
Both these fungi are very common on the sori of *Ustilago heterospora* on *Panicum maximum*, forming white to bright pink masses of mycelium and spores.

USTULINA sp.
Nectria stigme Rehm.

CONIFERAE.

CUPRESSUS sp.
Rhizoctonia lamellifera Small, in roots and base of stem, associated with die-back and eventual death of the tree.

PODOCARPUS MILANJIANUS.
Corynelia clavata (L.) Sacc., f. *macrospora* Syd.
Corynelia uberata Fr.

DICOTYLEDONES.

ANNONACEAE.

ANNONA CHERIMOLIA (Cherimoyer).
Phyllosticta sp., causing brown leaf-spots, on which a species of *Volutella* frequently occurs as a secondary saprophyte.

ANNONA MURICATA (Soursop).
Rhizoctonia lamellifera Small, has been found on the roots, which die back towards the base of the tree; eventually the tree may die, but the process is very slow, and recovery from the early stages of attack is frequent.
Triposporium sp., black patches on leaves.

ANNONA SQUAMOSA (Sweet Sop).

Colletotrichum sp., with *Glomerella cingulata* as its perfect stage, causes a fruit rot; it was cross-inoculated by Small into a number of other hosts.

ARTABOTRYS sp. (Indigenous).

Asterina artabotrydis Hansford, forming thin black patches on leaves.

Sphaerophragmium artabotrydis Hansford, rust on leaves; often overgrown by a black stromatic *Sphaeriaceous* fungus, at present unidentified.

LAURACEAE.

PERSEA AMERICANA (Avocado).

Glomerella cingulata (Ston.) Spaul. and Schrenk, causes a fruit rot.

Nematospora gossypii Ashby & Nowell, causes a hard, black rot of the seeds; the origin of the infection remains obscure, as the affected seed are enclosed by apparently sound fruit.

(*Cephaleuros mycoidea* Karst., an alga, forms green and red patches on the leaves, especially on trees growing in damp places.)

MYRISTICACEAE.

PYCNANTHUS KOMBO (Indigenous).

Asterina pycnanthi Hansford, thin, smooth, black patches on leaves.

RANUNCULACEAE.

CLEMATIS sp. (Indigenous).

Coleosporium clematidis Barcl., rust.

Aecidium englerianum Henn. & Lind., rust.

RANUNCULUS sp.

Aecidium sp. indet., rust.

MENISPERMACEAE.

CISSAMPELOS sp. (Indigenous).

Meliola cissampeli Hansford & Stevens. black leaf fungus.

Didymaria sp. (?), forms white mouldy patches on the lower surface of the leaf; later these turn brown and dry out; leaves severely attacked are shed.

PIPERACEAE.

PIPER GUINEENSE (Indigenous).

Meliola stenospora Wint., and

Irenina atra (Doidge) Stevens, black leaf fungi, the former record needs checking, as all recent collections belong to the latter species.

CAPPARIDACEAE.

CAPPARIS sp. (Indigenous).

Irenopsis bosciae (Doidge) Stevens, and

Asterina capparidis Syd. & Butl., are black fungi on leaves.

CLEOME MONOPHYLLA (Indigenous).

Peronospora cleomes Hansford, downy mildew on leaves.

CRUCIFERAE.

BRASSICA sp. (cult. Cabbage, Cauliflower, etc.).

Peronospora parasitica (Pers.) De Bary, downy mildew; hitherto recorded in Uganda only on a wild native species of this genus, which occurs as a common weed of cultivated land. The cultivated *Brassicas* appear to be immune to attack by this form of fungus.

Alternaria circinans (B. & C.) Bolle, forms dark brown circular zone spots on the leaves of cabbage and cauliflower around Kampala; usually confined to the older leaves.

Cercospora brassicola P. Henn., causes small grey to brown sunken spots on old leaves of cauliflower.

POLYGALACEAE.

POLYGALA sp. (Indigenous).

Uromyces polgalae Grove, rust.

CARYOPHYLLACEAE.

DIANTHUS sp. (Carnation, Pink, etc.).

Uromyces dianthi (Pers.) Niessl, rust; occurs wherever the hosts are grown in Uganda, but is rarely sufficient to cause damage.

Rhizoctonia bataticola (Taub.) Butl. (*Macrophomina phaseoli* (Maubl.) Ashby), and

Sclerotium rolfsii Sacc., cause root diseases of these hosts in Uganda, especially at the lower elevations, where the plants do not thrive well. Affected plants show a more or less sudden dying of one or more shoots, rapidly followed by death of the whole plant. The minute black sclerotia of the former fungus in the dead tissues serve to distinguish its attack from *S. rolfsii*, which forms a whitish mycelium and yellowish sclerotia on the surface of the stems at soil level. These diseases are hardly noticeable in new gardens cleared from thick elephant grass, but after about three or

four years they become more prevalent, and may entirely prevent the cultivation of these flowers in some gardens.

Septoria dianthi Desm. is common in Uganda, often causing somewhat severe damage to the foliage of carnations; it attacks the leaves about half way up, forming reddish patches, finally drying out to greyish black, and then covered with minute black pycnidia.

Heterosporium echinulatum (Berk.) Cooke causes another leaf spot of carnations.

Botrytis vulgaris (Lk.) Fr. causes a rotting of the fruit and seeds.

Alternaria tenuis Bolle, f., is common on older leaves, but no appreciable damage is caused.

Fusarium caudatum Wr., and forms of *F. oxysporum* Schlecht. and of *F. solani* (Mart.) Wr., are common on the roots and stems of plants attacked by the root diseases mentioned above, but we have no evidence of the occurrence of "carnation wilt" (*F. dianthi*) in Uganda.

DRYMARIA CORDATA (Indigenous).

Puccinia leptosperma Syd., rust.

MOLLUGINACEAE.

MOLLUGO NUDICAULIS (Indigenous).

Cystopus sp., forms white pustules on all aerial parts.

PORTULACACEAE.

PORTULACA sp. (Indigenous).

Cystopus portulacae (Lev.) De Bary, forms white pustules on leaves.

POLYGONACEAE.

POLGONUM sp. (Indigenous).

Uromyces polygoni (Pers.) Fckl., and *Puccinia polygoni-amphibii* Pers., are common rusts.

FAGOPYRUM ESCULENTUM (Buckwheat).

Botrytis sp. attacks the leaves, especially in periods of cool, moist weather, causing greenish patches, which later dry out to pale brown and become covered on the lower surface by a thin, mouldy growth of the conidiophores of the fungus, pale greenish-brown in colour. The whole appearance of the disease is that of a "downy mildew"; on occasion it causes serious defoliation of the host, thus spoiling its value as a cover crop, for which purpose it is grown in Uganda.

Phyllosticta (*polygonorum* Sacc.?), leaf

Cercospora sp., forms pale brown, small leaf-spots on the older leaves; not known to cause defoliation.

RUMEX sp.

Uredo sp., indet., rust.

PHYTOLACCACEAE.

PHYTOLACCA DODECANDRA (Indigenous).

Meliola phytolaccae Hansford & Stevens, black fungus on leaves and younger parts of stem.

Cercospora phytolaccae Hansford, leaf spot, sunken, semi-transparent.

Oidium sp., mildew.

CHENOPODIACEAE.

CHENOPODIUM ANTHELMINTICA (Wormseed).

Cercospora anthelmintica Atk., leaf spot, occasionally causing severe defoliation. This plant was cultivated at Kampala Plantation in trial plots, some of which failed badly; no definite disease due to fungus attack could be found in quantity sufficient to account for this failure.

CHENOPODIUM sp. (Indigenous).

Septoria chenopodii West., leaf spot.

AMARANTACEAE.

ACHYRANTHES sp. (Indigenous).

Peronospora sp., downy mildew.

Cystopus bliti, f. *achyranthis* P. Henn., white pustules on leaves.

Uredo sp., rust, often on same leaves as *Cystopus*.

AMARANTHUS sp. (Indigenous).

Cystopus bliti De Bary, "white rust" on leaves.

Cercospora (*amaranthi* Lobik?), leaf spot.

CYATHULA sp. (Indigenous).

Uromyces cyathulae P. Henn., only in *Uredo* form, rust.

Uredo gomphrenae Barcl., rust.

LINACEAE.

HUGONIA sp. (Indigenous).

Micropeltella sp., minute black, flat, circular "thyrothecia" on leaves.

GERANIACEAE.

GERANIUM sp. (Indigenous).

Uromyces geranii (DC.) Otth. & Wartm., rust.

Puccinia geranii-sylvatici Karst., rust.

PELARGONIUM sp. (cult. Garden Plants, and Essential Oils).

Pythium (*complectens* Braun ?), causes a rapid rotting of cuttings during propagation; considerable trouble was experienced at first with this disease in the nursery at Kampala, and eventually it was found advantageous to strike the cuttings in sterilized soil or sand. Plants in the field are occasionally affected, infection occurring by way of the roots.

Fusarium caudatum Wr. was frequently associated with the above, but proved incapable of initiating the disease alone.

OXALIDACEAE.

OXALIS sp. (Indigenous).

Oidium sp., mildew.

Mycosphaerella depazaeformis (Ces. and De Not.) Wakef., leaf spot.

Cercospora corniculatae Hansford, leaf spot.

PUNICACEAE.

PUNICA GRANATUM (Pomegranate).

Mycosphaerella lythracearum Wolf, leaf spot.

TROPAEOLACEAE.

TROPAEOLUM MAJUS (cult. Nasturtium).

Oidium sp., mildew, of common occurrence, but as a rule causes little trouble.

Cercospora (*tropaeoli* Atk.), leaf spot.

PROTEACEAE.

GREVILLEA ROBUSTA ("Silky Oak").

Nectria flavo-lanata B. & Br., on dead and dying branches; of no pathological importance.

Rhizoctonia lamellifera Small, root disease. In many parts of Uganda the host can only be considered as a temporary shade tree on account of the high incidence of this disease, which increases as the trees become older; at 10 to 15 years of age, few trees of the original stand in such areas remain alive. The disease commences in the fine roots, and gradually extends back along the main roots to the base of the trunk; the first obvious sign of disease is an exudation of dark gum from the trunk some feet above the ground, accompanied by a gradual dieback of the crown. Little can be done to control the disease, as the fungus appears to be widespread in Uganda soils. In some areas, such as Toro, the disease is less serious, and old plantations still remain more or less intact.

PROTEA MADIENSIS (Indigenous).

Leptosphaeria protearum Syd., leaf spot.

Hendersonia protearum Wakef., on leaves.

DILLENIACEAE.

TETRACERA ALNIFOLIA (Indigenous).

Uleomyces tetracerae Hansford, on leaves.

Hysterostomella tetracerae (Rud.) von Hohnel, forms circular black plates on the leaves, on both surfaces; strongly parasitic, and marked on the opposite side of the leaf by a white spot, often invaginated.

Asterina sp., black fungus on leaves.

BIXACEAE.

BIXA ORELLANA (Annatto).

Oidium sp., mildew, very common around Kampala from April to November every year, forming white patches on the leaves, which later turn dark brown under the mycelium of the fungus; little leaf-shedding occurs, and the damage is unimportant.

Rhizoctonia lamellifera Small, was recorded by Small from the roots of this host; the incidence appears to be small, and the present writer has seen no case of root disease of this plant.

FLACOURTIACEAE.

DOVYALIS MACROCALYX (Indigenous).

Meliola scolopiae Doidge, black fungus on leaves.

Irene natalensis (Doidge) Doidge, a similar fungus.

FLACOURTIA sp.

Meliola scolopiae Doidge, on leaves.

HYDNOCARPUS sp. (Chaulmoogra Oil).

Armillaria mellea (Vahl.) Fr., causes a root rot of this tree in Uganda, especially on moist land just cleared from forest. This host appears to be as susceptible as tea to this fungus, and much more so than coffee or rubber. It is therefore extremely important to destroy every possible source of infection, such as forest stumps and roots, before planting with this tree.

A rough, warty, corky excrescence is common in Uganda on the older

branches and twigs of this tree; often whole branches show a continuous line of such warts. From them only a *Septoria* sp. has been isolated here, and it is rather unlikely that this fungus is the cause. As far as is known, little harm results to the growth of the tree, as the disease is usually limited to the lower, shaded branches.

PASSIFLORACEAE.

ADENIA sp. (Indigenous).

Schiffnerula adeniae Hansford, on leaves.

Heterosporium adeniae Hansford, on leaves.

PASSIFLORA sp. (Indigenous, also cult.).

Schiffnerula passiflorae Hansford may be identical with *S. adeniae*, but in the absence of cross-inoculations it is not possible to determine whether the differences observed are due merely to growth on the two hosts.

Blastotrichum sp. and *Naemosphaeria* sp. are common parasites of *Schiffnerula*, under very moist conditions.

CUCURBITACEAE.

CUCUMIS sp. (Cucumber and Melon).

Erysiphe cichoracearum DC., in its *Oidium* stage, is occasionally seen as a mildew on the leaves. (*Note.*—No perithecial stages of any of the mildews found in Uganda have yet been recorded in this country.)

Rhizoctonia bataticola (Taub.) Butl. has been recorded on the roots of these plants, but the incidence is small, and no important damage has been experienced with this disease in Uganda.

MELOTHRIA sp. and MOMORDICA sp. (Indigenous Climbers).

Septoria cucurbitacearum Sacc., f. *macrospora* Wakef. causes leaf-spots on these plants.

HOST, indet.

Aecidium sp., rust.

Cercospora citrullina Cke., leaf spot.

BEGONIACEAE.

BEGONIA sp. (Cult. and Indigenous).

Bacterium tumefaciens EFS. , "crown gall", causing outgrowths on the base of the plants; death often follows.

Cercospora sp., leaf spot.

(*Heterodera marioni* Cornu), eel-worm, causing galls on the roots.

(To be continued.)